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THERMAL EFFECTS ON AQUATIC ORGANISMS. AN ANNOTATED BIBLIOGRAPHY OF THE 1978 LITERATURE

S. S. Talmage

Oak Ridge National Laboratory
Oak Ridge, Tennessee

January 1980

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An Annotated Bibliography of the 1978 Literature

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Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
NTIS price codes—Printed Copy: A08 Microfiche A01

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THERMAL EFFECTS ON AQUATIC ORGANISMS
AN ANNOTATED BIBLIOGRAPHY OF THE 1978 LITERATURE

Compiled and edited by

Sylvia S. Talmage

Ecological Sciences Information Center
Information Center Complex

Work sponsored jointly by the Electric Power Research Institute under agreement RTS-76-37 and the Division of Environmental Impacts, U.S. Department of Energy.

Date Published: January 1980

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C. C. Coutant and H. A. Pfuderer, *Thermal Effects on Aquatic Organisms — Annotated Bibliography of 1972 Literature*, ORNL/EIS-73/28 (June 1973).

C. C. Coutant, H. A. Pfuderer, and B. N. Collier, *Thermal Effects on Aquatic Organisms — Annotated Bibliography of the 1973 Literature*, ORNL/EIS-74/28 (October 1974).

H. A. Pfuderer, S. S. Talmage, B. N. Collier, W. Van Winkle, and C. P. Goodyear, *Striped Bass — A Selected, Annotated Bibliography*, ORNL/EIS-75/73 (March 1975).

C. C. Coutant, S. S. Talmage, R. F. Carrier, and B. N. Collier, *Thermal Effects on Aquatic Organisms — Annotated Bibliography of the 1974 Literature*, ORNL/EIS-75/28 (June 1975).

J. S. Mattice, H. A. Pfuderer, and B. N. Collier, *Chemistry and Effects of Chlorine in Aquatic Systems — A Selected, Annotated Bibliography*, ORNL/EIS-82 (March 1976).

C. C. Coutant, S. S. Talmage, R. F. Carrier, B. N. Collier, and N. S. Dailey, *Thermal Effects on Aquatic Organisms — Annotated Bibliography of the 1975 Literature*, ORNL/EIS-88 (October 1976).

S. S. Talmage, *Thermal Effects on Aquatic Organisms — An Annotated Bibliography of the 1976 Literature*, ORNL/EIS-124 (May 1978).

S. S. Talmage, *Thermal Effects on Aquatic Organisms — An Annotated Bibliography of the 1977 Literature*, ORNL/EIS-143 (December 1978).

R. F. Carrier and E. H. Hannon, *Entrainment: An Annotated Bibliography*, EPRI EA-1049, ORNL/EIS-136 (April 1979).

M. S. Uziel and E. H. Hannon, *Impingement: An Annotated Bibliography*, EPRI EA-1050, ORNL/EIS-135 (April 1979).

D. M. Opresko and E. H. Hannon, *Chemical Effects of Power Plant Cooling Waters: An Annotated Bibliography*, EPRI EA-1072, ORNL/EIS-134 (May 1979).

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ABSTRACT

This bibliography, containing 457 references from the 1978 literature, is the eighth in a series of annotated bibliographies on the effects of heat on aquatic organisms. The effects of thermal discharges at power plant sites are emphasized. Laboratory and field studies on temperature tolerance and the effects of temperature changes on reproduction, development, growth, distribution, physiology, and sensitivity to other stresses are included. References in the bibliography are divided into three subject categories: marine systems, freshwater systems, and estuaries. The references are arranged alphabetically by first author. Indexes are provided for author, keywords, subject category, geographic location of the study, taxon, and title (alphabetical listing of keywords-in-context of nontrivial words in the title).

INTRODUCTION

Since 1971 the Ecological Sciences Information Center (ESIC), Information Center Complex, Oak Ridge National Laboratory, in support of the Department of Energy's program of bioenvironmental research, has been compiling a computer-searchable data base on the effects of heated discharges from power plants on aquatic organisms. In 1976 the Electric Power Research Institute became a cosponsor of the project. The scope of the data base includes published literature on power plant site studies and related field and laboratory studies. Sources searched include the commercial data bases such as Biological Abstracts, BioResearch Index, DOE Energy Data Base, and Dissertation Abstracts as well as relevant journals and reports contained in the ORNL Central Research Library. The entries in the data bases are available for searching through ESIC. An annotated bibliography is published annually.

The literature on thermal effects has been reviewed annually for several years in the *Journal Water Pollution Control Federation*. The literature indexed in this bibliography forms the basis of the 1978 literature review compiled by S. S. Talmage and C. C. Coutant.

Data bases compiled by ESIC on thermal effects, impingment, entrainment, chemicals released in power plant cooling waters, and atmospheric and terrestrial effects of closed-cycle cooling systems have been combined and merged with a data base of unpublished literature on power plant effects compiled by the Atomic Industrial Forum. This combined data base on power plant cooling system effects was created for the Electric Power Research Institute and is available for searching through the Atomic Industrial Forum, Washington, D.C.

Citation Form

The bibliographic data are arranged according to the ESIC format. As a result of computer limitation in indicating superscripts and subscripts in the standard manner, certain conventions have been established in the bibliography:

1. For subscripts, X sub t is used for X_t.
2. In chemical compounds and elements, NaIO3 is used for $NaIO_3$.
3. In exponential functions, 10(E+3) or X(E-2) is used for 10^3 or X^{-2} respectively.
4. For units of measurement such as cubic centimeters or square feet, X3 is used for X^3.

ACKNOWLEDGMENTS

Charles C. Coutant of the Environmental Sciences Division, Oak Ridge National Laboratory (ORNL), provided guidance for this project. Opal Russell of the ORNL Central Research Library and Betty Cornett of the Ecological Sciences Information Center acquired the documents. Debbie Northern of the Information Sciences and Operations Department, Information Center Complex, managed the computer production of this document.

<1>
Adamek, Z., and P. Obrdlik, University of
Agriculture, Department of Fisheries and
Hydrobiology, Brno, Czechoslavakia

Food of Important Cyprinid Species in the Warmed
Barb-Zone of the Oslava River.
Folia Zool. 26, 171-182 (1977)

Diatoms were the more abundant group of periphyton in both the warmed and non-warmed sections of the Oslava River, Czechoslovakia. NAVICULA AVENACEA and NAVICULA RHYNCHOCEPHALA had the widest distribution in the river. In control sections of the river, zoobenthos was dominated by Chironomidae, Ephemeroptera, Oligochaeta, and Trichoptera-Annulipalpia. In the warmed sections zoobenthos was reduced, and ANCYLUS FLUVIATILIS, Plecoptera, and Simuliidae were absent. Food habits of several cyprinid species were studied. Zoobenthos was the major component of the diet of barb, but filamentous algae and diatoms were also eaten. Nase consumed diatoms almost exclusively, except in the warmed sections where ingestion of organic detritus was high. Chub consumed detritus, soil macrovegetation, and periphyton. The main food components of the dace were filamentous algae and diatoms. Both chub and dace consumed benthos infrequently. More food was consumed by fish in the warmed sections, but sampling variation was great. (ST)

<2>
Adelman, I.R., University of Minnesota,
Department of Entomology, Fisheries, and
Wildlife, St. Paul, MN

Influence of Temperature on Growth Promotion and
Body Composition of Carp (CYPRINUS CARPIO)
due to Bovine Growth Hormone.
Trans. Amer. Fish. Soc., 107, 747-750 (1978)

Yearling carp held at four constant temperatures were injected with bovine growth hormone. A relative greater responsiveness to growth hormone injections was found at below-optimum temperatures of 9.2 and 19.5 C and the above-optimum temperature of 35.8 C than at the optimum temperature for growth, 29.6 C. There was no significant effect of the hormone on body composition. (Auth)

<3>
Akesson, B., and J.D. Costlow, University of
Gothenburg, Department of Zoology,
Gothenburg, Sweden; Duke University Marine
Laboratory, Beaufort, NC

Effects of Temperature and Salinity on the Life
Cycle of OPHRYOTROCHA DIADEMA (Polychaeta,
Dorvilleidae).
Ophelia (Den.), 17, 215-229 (1978)

OPHRYOTROCHA DIADEMA is stenohaline. At an optimum salinity, 35 g/l, reproduction occurs between 11 and 27 C. Experiments were performed in 5 g/l steps of salinity from 15 to 45 g/l combined with temperatures of 15, 18, 21 and 25 C. At salinities of 15 and 20 g/l all animals died within two days. In the remaining combinations adults were kept for 3 weeks and larvae for one month. Optimum conditions for survival were obtained at 35 g/l salinity and 18 C. The optimum for egg production (reproductive rate) was 35 g/l and 25 C. The maximum growth rate was observed at 30 and 35 g/l salinity and 25 C. These two combinations also represented the shortest time of development to sexual maturity. The number of eggs per egg mass was significantly salinity dependent, with an optimum at 35 g/l, but was not affected by temperature, except at 40 g/l salinity, or by salinity/temperature interaction. At low temperatures, 15 and 18 C, survival was better at 40 than at 25 g/l salinity. At 21 and 25 C the relations were reversed. The growth rate figures indicate a similar change, which occurs between 15 and 18 C. At 15 C the larvae maintained at 40 g/l salinity were superior, but at higher temperatures, the higher survival was observed for larvae reared at 25 g/l. (Auth) (MU)

<4>
Al-Habbib, O.A.M., and J.N.R. Grainger, Trinity
College, Zoology Department, Dublin, Ireland

The Effect of Constant and Changing Temperatures
on the Thermal Resistance of LYMNAEA PEREGRA
(Muller).
Jour. Thermal Biol., 2, 191-195 (1977)

The effect of constant and changing temperatures on both high and low lethal temperatures of LYMNAEA PEREGRA and the time course of acclimation were investigated. Snails acclimated to 6.5, 11.5, and 16.5 C showed paradoxical 'adaptation' of their high lethal temperature and reasonable 'adaptation' of the low lethal temperature. This combination is thus observed for the first time in molluscs. Seasonal variation in the upper lethal temperature showed parallel changes and the snails became less resistant to heat during spring and summer. Acclimation to changing temperature conditions did not extend their temperature tolerance range. During the course of acclimation of 6.5 C snails to 16.5 C, about 70% of the acclimation was completed within the first 24 h and the rest was completed within 360 h at 16.5 C. (Auth)

<5>
Alabaster, J.S., and B. Stott, Water Research
Centre, Stevenage Laboratory, England;
Salmon and Freshwater Fisheries Laboratory,
Ministry of Agriculture, London, England

Swimming Activity of Perch, PERCA FLUVIATILIS L.
Jour. Fish Biol. 12, 587-591 (1978)

Seasonal changes in total daily activity of perch appeared to be related to water temperature. In the laboratory, activity increased from March (6 C) to April (10 C) to May (16 C). In the field, however, swimming activity was much greater in spring than in the laboratory at the same temperature and was also greater at the same temperature in fall. (ST)

<6>
Alderdice, D.F., and F.P.J. Velsen, Department of
Fisheries and the Environment, Fisheries and
Marine Service, Pacific Biological Station,
Nanaimo, British Columbia, Canada

Relation between Temperature and Incubation Time
for Eggs of Chinook Salmon (ONCORHYNCHUS
TSHAWYTSCHA).
Jour. Fish. Res. Bd. Can., 35, 69-75 (1978)

With data assembled from the literature, relations are examined between incubation temperature and rate of development from fertilization to hatching for chinook salmon (ONCORHYNCHUS TSHAWYTSCHA) eggs. Ten forms of three empirical relations are used, based on the thermal sums hypothesis, Belehradek's equation, and a form of the logistic curve. In each case comparisons are made using constant, ambient, and combined (constant + ambient) incubation temperatures. In most cases the rules of minimum variance curve fitting are somewhat violated, although results using the log-inverse form of

<6>
<6> CONT.

Belehradek's equation are superior to those from the other models. Early imposition of low, constant incubation temperatures (below 6 to 7 C) appears to slow egg development below those rates occurring at ambient temperatures having the same mean values. Time-temperature relations based on the unmodified thermal sums hypothesis and its associated "degree-days" are compared with predicted values obtained using the log-inverse Belehradek model as a standard. The former model tends to underestimate the length of the incubation period by an average of about 5 days at incubation temperatures above 4 C; below 4 C the former model increasingly overestimates the incubation period. Based on the log-inverse Belehradek model, a table is provided of predicted daily rates of development in relation to temperature. The table may be used to predict hatching time in a manner similar to that employing degree-days. In general, the enquiry points to a lack of data on development time at temperatures below 5 C; to be meaningful, further analyses will require such data. (Auth)

<7>
Allan, J.D., University of Maryland, Department of Zoology, College Park, MD

An Analysis of Seasonal Dynamics of a Mixed Population of DAPHNIA, and the Associated Cladoceran Community.
Freshwater Biology, 7, 505-512 (1977)

The dynamics of a mixed population of DAPHNIA (D. AMBIGUA and D. PARVULA) were analysed over 9 months in a small eutrophic lake. A spring peak of D. AMBIGUA occurred shortly after ice break-up. Decline of D. AMBIGUA coincided with a high occurrence of sexual reproduction, the appearance of D. PARVULA which did not become abundant, and a substantial increase in CERIODAPHNIA QUADRANGULA. A third cladoceran, BOSMINA LONGIROSTRIS, was abundant before and after the period of numerical dominance by D. AMBIGUA, but declined to very low numbers coincident with the increase in D. AMBIGUA. Estimates of egg hatching rate at various temperatures demonstrate that these three cladocerans have different rate reponses to temperature, and that seasonal succession of species is predictable from temperature alone. The importance of temperature versus species interactions in controlling species succession is discussed. (Auth)

<8>
Alston, D.E., Auburn University, Auburn, AL

Effects of Heated Water Upon Fish-Food Organisms in Three Artificial Channels.
Ph.D. Thesis, Auburn University, 62 pp. (1978)

Three earthen channels, constructed at the Green County, AL, steam-electric generating plant, were used in a two-year study to evaluate the effects of heated effluents on aquatic biota. The channels received (1) unheated river water (control), (2) both heated and unheated water, and (3) heated water only. Results of dredge and plate sampling indicated differences in densities and species diversity among the channels. Lower diversity, with fewer mayflies, was noted in the channel receiving only heated water. (ST)

<9>
Ames, W.E., J.R. Hughes, and G.F. Slusser, NOAA, National Marine Fisheries Service, Seattle, WA

Upper Lethal Water Temperature Levels for English Sole (PAROPHRYS VETULUS) and Rock Sole (LEPIDOSETTA BILINEATA) Subjected to Gradual Thermal Increases.
Northwest Science, 52, 285-291 (1978)

English sole and rock sole (80 to 360 mm) from Puget Sound, Wash., were subjected to thermal stress tests in continuous flow sea water that was gradually raised from ambient temperature (6.9 to 13.9 C) to test temperatures (18, 21, 24, or 27 C) over a one hour period. Test temperatures were held for 4 hr, then gradually reduced to ambient over the next hour. The lethal level at which 50% of the fish survived was 26.1 C for English sole and 24.9 C for rock sole during the 27 C test. The lethal level was not reached at any other test temperature. Aproximately 60% of the mortalities occurred during the seven-day observation period following the tests. Test anials in the 120 to 280 mm length group were the most temperature tolerant. (ST)

<10>
Anderson, G., University of Maine, Department of Zoology, Orono, ME

Metabolic Rate, Temperature Acclimation and Resistance to High Temperature of Soft-Shell Clams, MYA ARENARIA, as Affected by Shore Level.
Comp. Biochem. Physiol., 61A, 433-438 (1978)

Metabolic rates, temperature acclimation pattern and mortality resistance at high temperature were determined for MYA ARENARIA collected in summer from four beach levels at Blue Hill Falls, ME. For a clam of intermediate size, metabolic rate is highest at the high intertidal level and lowest at the low intertidal level; subtidal and mid intertidal clams exhibit intermediate rates. Bivalves from the low intertidal level exhibited near-complete (Precht type 3--92.4%) metabolic compensation to temperature change while those from mid and high intertidal levels showed partial compensation (Precht type 3--61% and 32.5%, respectively) after 2 weeks. Subtidal clams exhibited supraoptimal compensation (Precht type 1); warm acclimated clams from this level were metabolically temperature independent over the range of 10 to 25 C. Subtidal and high intertidal clams are better able to withstand high temperature (25 C) than clams from low and mid intertidal levels. (Auth)

<11>
Andrzejczak-Czechowska, I., and R.J. Wisniewski, Polish Academy of Sciences, Department of Hydrobiology, Institute of Ecology, Lomianki, Poland

Effect of Heated Waters on Biocenosis of the Moderately Polluted Narew River. Periphyton.
Pol. Arch. Hydrobiol., 23, 519-526 (1976)

The effect of heated waters discharged from the power station on the periphyton algae communities was studied in the slightly polluted lowland Narew River (Poland). The discharge of heated water caused a rise of temperature of the river waters by about 2 C in summer. In the most strongly heated sector of the river a decrease in the density of periphyton algae and in the number of diatom species was observed as well as an increase in the ratio of the indicator-forms of alpha-mesosaprobity, especially in warm seasons of the year. The decrease in the number of diatoms species and the increase in the ratio of the forms indicating alpha-mesosaprobity were also observed in the summer and autumn in the most strongly polluted sector of the river,

<11> CONT.
which was downstream below the discharge of the wastes from the sewage treatment plant at Ostroleka. (Auth)

<12>
Armitage, B.J., T.D. Forsythe, E.B. Rodgers, and W.B. Wrenn, Tennessee Valley Authority, Division of Forestry, Fisheries, and Wildlife Development, Biothermal Research Section, Decatur, AL

Browns Ferry Biothermal Research Series. I. Colonization by Periphyton, Zooplankton, and Macroinvertebrates.
EPA-600/3-78-020, Environmental Research Laboratory, Duluth, MN, 46 pp.: NTIS, Springfield, VA (1978)

Colonization studies on a series of 12 outdoor experimental channels supplied with water from Wheeler Reservoir (Tennessee River) were completed at the Browns Ferry Biothermal Research Station in Alabama. Species composition, dominance, seasonal patterns, colonization rates, and biomass estimates were determined over a 24-month period for periphyton, zooplankton, and macroinvertebrates. In general, the species composition and the relative densities of algal and invertebrate organisms that colonized the channels indicated that the channels successfully simulate reservoir ecosystems for those tropic levels. (Auth)

<13>
Backiel, T., University of Tromso, Institute of Biology and Geology, Norway

An Equation for Temperature Dependent Metabolism or the "Normal Curve" of Krogh.
Pol. Arch. Hydrobiol., 24, 305-309 (1977)

The empirical normal curve of Krogh showing the generalized relationship between standard metabolism in animals and temperature can be approximated by the equation: R sub t = R sub 20 x (0.3e(E+0.071t) minus 0.24), where R sub t and R sub 20 are metabolic rates at temperature t C and 20 C and 20 C, respectively. (Auth)

<14>
Barker, S.L., and J. Stewart, University of Maine at Orono, Ira C. Darling Center, Walpole, ME

Mortalities of the Larvae of Two Species of Bivalves after Acute Exposure to Elevated Temperature.
In Fourth National Workshop on Entrainment and Impingement, L.D. Jensen (Ed.). EA /Communications, Melville, NY, (pp. 203-210), 424 pp. (1978)

Experiments designed to assess the effect of short-term exposures to elevated temperature on the larvae of MYTILUS EDULIS and MYA ARENARIA are described. These studies were undertaken because of the general lack of published data on the tolerance of common and commercially important species with pelagic larvae subjected to entrainment with condenser cooling water in coastal regions of northern New England. The temperature regimes to which organisms were subjected simulate those of a condenser cooling water system with a diffuser discharge. A thermal gradient apparatus, consisting of an aluminum block heated at one end, cooled at the other, and bored to hold 88 test tubes in an 8-X-11 matrix, was used to subject larvae to differing levels of temperature increase for exposure times of from 5 to 180 minutes (with replicates). Organisms tested were held for 24 hours after exposure to allow for delayed mortality. Neutral red

<11>
stain was used to differentiate beteen live and dead organisms. Definitive results covering a range of temperature-time combinations were obtained. These results expressed as a response surface allow prediction of mortality at combinations of temperature and time other than those tested. (Auth)

<15>
Barton, M.G., Oregon State University, Corvallis, OR

Influence of Temperature and Salinity on the Adaptation of ANOPLARCHUS PURPURESCENS and PHOLIS ORNATA to an Intertidal Habitat.
Ph.D. Thesis, Oregon State University, 114 pp. (1978)

The influence of temperature and salinity on the distribution of two coexistent species of blennioid fish in Yaquina Bay was evaluated. PHOLIS ORNATA inhabited rocky intertidal substrates in the upper part of the bay while ANOPLARCHUS PURPURESCENS predominated in the intertidal zone at the mouth of the bay. Measurements of the microhabitat temperatures and salinities revealed only slight environmental fluctuations. Laboratory tested critical thermal maxima were 29.5 C for A. PURPURESCENS and 31.0 C for P. ORNATA. Administration of thermal stress in a cycled program simulating tidal exposure and inundation sharply differentiated the thermal tolerances of the two species. Salinity influenced the thermal capacities of the species in a manner which reflects their distribution in the bay. Comparison of temperatures and salinities measured in the field with laboratory determined tolerances revealed that temperature is not a limiting factor in the comparative distribution of the species in estuaries. (Auth) (ST)

<16>
Bass, M.L., C.R. Berry, Jr., and A.G. Heath, Virginia Polytechnic Institute and State University, Department of Biology, Blacksburg, VA

Histopathological Effects of Intermittent Chlorine Exposure on Bluegill (LEPOMIS MACROCHIRUS) and Rainbow Trout (SALMO GAIRDNERI).
Water Res. (G.B.), 11, 731-735 (1977)

Fish were exposed to multiple pulses of free residual chlorine in the water at four concentrations ranging from sublethal to lethal levels. Histological examinations were made of moribund fish and those surviving the exposures. Sublethal concentrations caused moderate gill hyperplasia and swelling of the lamellar epithelial cells. Lethal concentrations caused extensive hyperplastic lesions of gill epithelium. No kidney damage was seen in any of the fish. Liver glycogen was severely depleted, probably as a result of the hypoxemia produced by the gill damage. Hepatic necrosis was seen in fish exposed to high chlorine concentrations and these lesions were more extensive at elevated temperatures. From these observations and other physiological studies, it is concluded that death in fish from exposure to several pulses of free residual chlorine is due primarily to histological damage to the gills causing blockage of respiratory gas transport across the gill epithelium. (Auth)

<17>
Batac-Catalan, Z., and J. Cairns, Jr., University of Michigan, School of Natural Resources, Ann Arbor, MI; Virginia Polytechnic

<17>
<17> CONT.
Institute and State University, Department of Biology and Center for Environmental Science, Blacksburg, VA

Survival of DAPHNIA PULEX under Thermal Stress and Sublethal Concentrations of Chromate.
Kaliksan, Philipp. Jour. Biol., 6, 47-54 (1977)

The effects of chromium (0.1, 1.0, 10, 100, and 1000 ppm) and thermal shock (5, 10, and 20 C above an ambient temperature of 21 C) on the survival of DAPHNIA PULEX were studied in vitro. An increase of 20 C above ambient killed the organism instantaneously. Prior exposure to sublethal amounts of the toxicant (0.52 ppm) appeared to stimulate the organism to elicit some physiological mechanisms to cope with this stress and subsequent heat shock. Survival time in a combination of heat and chemical stress was 30 and 1.3% lower than with heat shock and chemical stress, respectively. (Auth) (ST)

<18>
Bayne, B.L., J.M. Gee, J.T. Davey, and C. Scullard, Institute for Marine Environmental Research, Plymouth, England

Physiological Responses of MYTILUS EDULIS L. to Parasitic Infestation by MYTILICOLA INTESTINALIS.
Jour. Cons. Int. Explor. Mer (Den.), 38, 12-17 (1978)

Various levels of infestation by MYTILICOLA had no effect on the rates of oxygen consumption by MYTILUS EDULIS in laboratory experiments. However, high levels of infestation (more than 10 parasites per mussel) caused a depression in the feeding rate of the host at high temperatures (22 or 23 C) and low ration (maintenance or sub-maintenance). This depression of feeding resulted in a decline in the scope for growth, which would result in time in a decline in the "condition" of the host. It is concluded that similar effects may occur in the field when large numbers of small parasites are present at a time of high metabolic demand and low food availability. (Auth)

<19>
Bayne, B.L., D.L. Holland, M.N. Moore, D.M. Lowe, and J. Widdows, Institute for Marine Environmental Research, Plymouth, Great Britain; N.E.R.C. Unit of Marine Invertebrate Biology, Marine Science Laboratory, Menai Bridge, Great Britain

Further Studies on the Effects of Stress in the Adult on the Eggs of MYTILUS EDULIS.
Jour. Mar. Biol. Assn. U.K., 58, 825-841 (1978)

Mussels (MYTILUS EDULIS L.) were held under five different experimental conditions for eight weeks during which measurements of physiological condition, and certain cytological and cytochemical observations, were made. The mussels were then induced to spawn and the numbers of eggs released, the weights of these eggs, and their biochemical composition, were determined. During the experiment new gametes were developed by mussels under all conditions, but there was also a simultaneous regression and resorption of previously formed gametes, particularly in mussels under the greatest stress from high temperature (18 C compared to 11 C) and lack of food. The degree of stress experienced by the animals was measured as the scope for growth, or the energy available for somatic growth and the production of gametes. The distribution and activity of lysosomal enzymes within the Leydig tissue of the mantle suggested that autolysis of these cells occurred, coupled to the mobilization of glycogen for gametogenesis. Mussels under stress produced fewer and smaller eggs, in smaller follicles, than mussels not under stress. The biochemical composition of the eggs (as ug of biochemical component per mg of egg) did not vary consistently with adult condition, but eggs from stressed females had less lipid and protein than eggs from normal females. It is suggested that these relationships between the physiological condition of the adult, gametogenesis, fecundity and the biochemical content of the eggs are important for understanding the impact of the environment on ecological fitness. (Auth)

<20>
Bayne, B.L., and C. Scullard, Institute for Marine Environmental Research, Plymouth, England

Rates of Feeding by THAIS (NUCELLA) LAPILLUS (L.).
Jour. Exp. Mar. Biol. Ecol. (Neth.), 32, 113-129 (1978)

A hyperbolic relation between size of THAIS LAPILLUS (L.) and preferred prey (MYTILUS EDULIS L.) size has been found. Times spent drilling and ingesting the prey did not vary for snails of different sizes, but were shorter at higher temperatures (15 and 20 C compared to 9 C). There was an allometric relation between prey size and the duration of a post-feeding phase: this relationship also was sensitive to temperature. Feeding was more intense in the summer than winter, and this was not due solely to the higher temperatures in the summer. During the winter enforced starvation did not result in greatly increased feeding activity, but in the summer the longer the period of starvation the more intense was the feeding behaviour. Assimilation efficiency of THAIS for MYTILUS flesh was 66%. These results, together with values for oxygen consumption from a related study, were used to predict growth and net energy intake values for THAIS of different sizes. (Auth)

<21>
Bayne, B.L., and C. Scullard, Institute of Marine Environmental Research, Plymouth, United Kingdom

Rates of Oxygen Consumption by THAIS (NUCELLA) LAPILLUS (L.).
Jour. Exp. Mar. Biol. Ecol. (Neth.), 32, 97-111 (1978)

Oxygen consumption by THAIS varied seasonally with higher values in summer than in winter. This seasonal difference was due to the effects of temperature and in part to those of feeding. During feeding, rates of oxygen consumption were high, but declined in the period between meals. There was little evidence of acclimation of oxygen consumption to changes in temperature: low (winter) rates of consumption were more sensitive to increases in temperature than were high (summer) rates. A polynomial expression, including terms for temperature and "time since last meal," was derived for the constant a' in the allometric equation relating oxygen consumption (V sub O_2) to dry body weight: V sub O_2 = a' x W(E+0.511). (Auth)

<22>
Bayne, B.L., J. Widdows, and C. Worrall, Institute for Marine Environmental Research, Plymouth, England

Some Temperature Relationships in the Physiology of Two Ecologically Distinct Bivalve

<22> CONT.
Populations.
In Physiological Responses of Marine Biota to Pollutants, F.J. Vernberg et al. (Eds.). Academic Press, Inc., New York, (pp. 379-400) (1977)

Mussels (MYTILUS EDULIS) were sampled from a typical estuarine mud-flat population on the south coast of England (control) and from a population adjacent to the cooling-water discharge of an electric power station. The control population had a high density of individuals and long term stability of numbers. The second population was subjected to an extremely variable temperature regime which averaged 2 to 6 C higher than that of the control. Following laboratory testing, the following observations were recorded. The control population showed a marked seasonal change in tolerance to high temperature (30 C); the power-station population showed less seasonal variability. Seasonal changes in tolerance were related to the reproductive condition of the animals. Small individuals were always more tolerant of high temperatures than were large mussels. In most cases acclimation to high temperatures enhanced thermal tolerance compared to acclimation to low temperatures. No simple relationship was found between metabolic rate and thermal tolerance. A temperature of 25 C imposed a significant sublethal stress on M. EDULIS. Mussels from the control population were more susceptible to acute temperature changes between 10 and 28 C, as measured by filtration rate, than were mussels from the power station. Acclimation to fluctuating temperatures enhanced the mussels' capacity to function at high temperature. Scope for growth at 29 C was negative; however, both populations held at fluctuating tempeatures (21 to 29 C) showed an anti-clockwise rotation in the curve relating scope to acclimation temperature and the degree of rotation was more marked for individuals from the power station than from the control. (ST)

<23>
Beall, S.E., C.C. Coutant, M.J. Olszewski, and J.S. Suffern, Oak Ridge National Laboratory, Oak Ridge, TN

Energy from Cooling Water.
Ind. Water Eng., 14, 8-14 (1977)

The reuse of industrial water for its heat content is considered. Waste heat utilization systems, both research efforts and presently operating systems, are reviewed. These include cogeneration (supplying heat and electricity from electric generating stations), heating and cooling of greenhouses and animal shelters, sea water distillation, and aquaculture. The site specific nature of the projects and the need for joint effort among several disciplines are discussed. (ST)

<24>
Becker, C.D., and M.P. Fujihara, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, WA

The Bacterial Pathogen FLEXIBACTER COLUMNARIS and Its Epizootiology among Columbia River Fish.
Amer. Fish. Soc. Monograph No. 2, Washington, D.C. (1978)

The report reviews characteristics and the host relationship of columnaris disease, environmental and associated factors influencing pathogenesis and consequent epizootiology of the disease among Columbia River fish. Research data from studies conducted at Pacific Northwest Laboratories

<22>
(Wash.) from 1965 to 1976 is also reviewed. The authors' assessment clearly indicates that pathogenesis of columnaris is modified by water temperature, that the impact on fish populations is related to virulence, and that high-virulence strains are now widespread among Columbia River fish, as well as in other waters of the Pacific Northwest. There was no evidence that operation of the plutonium production reactors at Hanford from 1944 to 1970 contributed significantly to the epizootiology of the disease among Columbia River fish. Instead, disease epizootiology was attributed to environmental modifications associated with hydroelectric development over the last three decades. The modifications have resulted in transformation of the river into a near consecutive series of dams and reservoirs. Future disease outbreaks will be influenced by low river flow and resultant temperature increases. (ST)

<25>
Bellan-Santini, D., and G. Desrosiers, Station Marine d'Endoume, 13007 Marseille, France

Effect of Thermal Pollution from the Martiques-Ponteau Plant on Hard Substratum Populations Dominated by Zoobenthos in the Upper Part of the Infralittoral Layer.
Tethys, 8, 83-92 (1976 (1977))

Six stations located in a gulf receiving pollution from several sources were studied. One station was influenced by the thermal effluent from the Martiques-Ponteau power station. The effects of chemical and organic pollution on the upper portion of the rocky shore infralittoral layer and the effects of thermal pollution on one of the observed rock layers were noted. The moderate thermal pollution did not fundamentally modify the composition of the populations, but did aggrevate the effects of the other types of pollution. (ST)

<26>
Bellinger, E.G., University of Manchester, Pollution Research Unit, Manchester, England

Seasonal Size Changes in Certain Diatoms and Their Possible Significance.
Brit. Phycol. Jour., 12, 233-239 (1977)

Cell sizes of two species of diatoms, STEPHANODISCUS ASTRAEA and ASTERIONELLA FORMOSA, were determined in algal populations in four water bodies at various times of the year. Changes in the average cell diameter or length were observed throughout the growing seasons. The possible effects of these cell size changes are discussed in relation to parameters such as rate of sinking, nutrient absorption, temperature, viscosity and turbulence. Diatom populations underwent their maximum increases in numbers in the spring when water temperatures increased from about 4 to 10 C. (Auth)(MO)

<27>
Berenbeim, D.Y., and I.K. Sigaev, Atlantic Research Institute of Marine Fisheries (AtlantNIRO), Kaliningrad, USSR

On the Correlation between Water Temperature and the Spawning Times for Georges Bank Herring.
International Commission for the Northwest Atlantic Fisheries, Selected Papers Number 3, 57-59 (1978)

Correlations between the times of peak herring spawning on Georges Bank and three water temperature indices indicate that knowledge of the near-bottom water

<27>
<27> CONT.

temperature conditions on the spawning grounds in August is suitable for predicting the time of peak spawning in September. (Auth)

<28>
Berrien, P.L., National Marine Fisheries Service,
Northeast Fisheries Center, Sandy Hook Laboratory, Highlands, NJ

Eggs and Larvae of SCOMBER SCOMBRUS and SCOMBER JAPONICUS in Continental Shelf Waters between Massachusetts and Florida.
Fishery Bull., 76, 95-115 (1978)

Larval SCOMBER SCOMBRUS and SCOMBER JAPONICUS from the western North Atlantic Ocean are compared. At 4 to 11 mm S. JAPONICUS are deeper bodied, and at 3 to 15 mm have greater preanus lengths than S. SCOMBRUS of comparable sizes. SCOMBER SCOMBRUS larvae are more heavily pigmented than S. JAPONICUS, particularly on the dorsal trunk surface and at the cleithral sympysis. In continental shelf waters between Martha's Vineyard, Mass., and Palm Beach, Fla., 1966-68, S. SCOMBRUS eggs occurred north of Cape Hatteras, N.C., mostly in the shoreward half of shelf waters during spring and summer. Surface temperatures associated with egg occurrences varied from 6.3 to 16.9 C. SCOMBER JAPONICUS eggs were taken south of Cape Hatteras, in the outer half of shelf waters, during winter and spring cruises. Surface temperatures associated with egg occurrences ranged from 20.4 to 25.4 C. Larval S. SCOMBRUS occurred north of Cape Hatteras during spring and summer with concurrent surface temperatures ranging from 12.3 to 20.7 C. With the exception of three specimens, S. JAPONICUS larvae occurred south of Cape Hatteras and were taken where the surface temperature ranged from 16.0 to 29.4 C. (Auth)

<29>
Blaber, S.J.M., and A.R. Whitfield, University of Natal, Zoology Department, Pietermaritzburg, South Africa

The Biology of the Burrowing Goby CROILIA MOSSAMBICA Smith (Teleostei, Gobiidae).
Environ. Biol. Fish., 1, 197-204 (1977)

As part of a study of the biology of the burrowing goby, salinity and temperature tolerances were determined. CROILIA MOSSAMBICA was euryhaline and survived direct transfer from freshwater to 70% seawater. Direct transfer from freshwater to seawater of 35 ppt caused a 40% mortality. When tested in freshwater from its collection site, the upper temperature tolerance was between 32 and 35 C. (ST)

<30>
Block, R.M., University of North Dakota, Grand Forks, ND

Effects of Temperature and Salinity on the Osmotic Adjustment in the Euryhaline Rainbow Trout, SALMO GAIRDNERI Richardson and the Stenohaline Channel Catfish, ICTALURUS PUNCTATUS (Rafinesque).
Ph.D. Thesis, 177 pp. (1974)

Channel catfish, ICTALURUS PUNCTATUS, were acclimated to various temperatures (2, 10, 20, and 30 C) in both freshwater and 30% seawater. Rainbow trout, SALMO GAIRDNERI, were acclimated to various temperatures (1, 10, and 20 C) in freshwater, 50% seawater, and full strength seawater under otherwise constant laboratory conditions. Isomotic conditions (30% seawater) did not affect hematocrit values in channel catfish as compared to freshwater values, although these values were reduced 50% in cold-adapted fish as compared to warm-adapted fish. Plasma cholesterol levels were not significantly altered by temperature or salinity, but total tissue lipids were reduced at the colder temperatures in freshwater-adapted channel catfish. Both plasma protein and glucose levels were depressed in fish held at the colder temperatures in both freshwater and 30% seawater. In catfish acclimated to 2 C tissue water was increased by 3% above the level in fish acclimated at 30 C in freshwater. In 30% seawater, tissue water was only increased by 1% at 2 C compared with fish held at 30 C. Plasma osmolarity and sodium and chloride levels were significantly decreased at the colder temperatures in freshwater-adapted fish. Plasma osmolarity and sodium and chloride levels were well regulated in fish maintained in 30% seawater at 10, 20 and 30 C. Plasma potassium levels appear to be well regulated in channel catfish adapted to both freshwater and 30% seawater at all temperatures. Both plasma calcium and magnesium levels were regulated in freshwater-adapted catfish at all temperatures. Rainbow trout acclimated to freshwater did not show change in hematocrit, plasma cholesterol, protein, urea, or tissue lipid levels at any of the acclimation temperatures. The erythrocyte number and tissue lipid levels were increased in fhis acclimated to 100% seawater held at the coldest temperature, but plasma cholesterol and glucose levels remained unchanged. Plasma urea levels in seawater-adapted rainbow trout were two-fold higher at 1 and 10 C than other experimental temperatures. Freshwater-adapted rainbow trout display excellent osmoregulatory ability with respect to tissue water, plasma osmolarity, sodium, chloride, potassium, calcium and magnesium levels at all acclimation temperatures. (Auth)(ST)

<31>
Bloom, S.G., B.W. Cornaby, and W.E. Martin, Battelle Columbus Laboratories, Columbus, OH

A Guide to Mathematical Models Used in Steam Electric Power Plant Environmental Impact Assessment.
FWS/OBS-78/01, U.S. Fish and Wildlife Service, Division of Engineering, Portland, OR (1977)

A nontechnical overview of modeling approaches for predicting and assessing environmental impacts of power plant operation on fish and wildlife resources is presented. The guide is written primarily for the reviewer of environmental documents. It introduces the reviewer to the principal types of mathematical models currently used as aids for predicting the environmental impacts of thermal power plant operation. It provides a general overview of the modeling approach to impact prediction: identifies the principal kinds of problems to which modeling is applied; and explains the requirements, usefulness, and limitations of models. The models discussed are categorized into process, hydrodynamic, aquatic dispersion, atmospheric dispersion, biological transfer, and biological effects models. A bibliography is provided. (ST)

<32>
Bodoy, A., and M. Masse, Station Marine d'Endoume, Marseille, France

Temperature Tolerance of Some Marine Molluscs of the Mediterranean North-West Coast.
Bull. Ecol., 8, 91-101 (1977)

<32> CONT.

Median lethal temperatures (TL50's) and median burial temperatures (TE50's) of several species of molluscs from the Mediterranean coast are given in graphical form. Species investigated were CARDIUM TUBERCULATUM, NASSARIUS PYGMAEUS, VENUS GALLINA, CORBULA GIBBA, CERITHIUM VULGATUM, CYCLONASSA NERITEA, SPISULA SUBTRUNCATA, DONAX SEMISTRIATUS, D. TRUNCULUS, and TELLINA TENUIS. Both TL50's and TE50's increased with increasing acclimation temperatures of 10 to 25 C. The highest TL50 values were found in species living in the shallowest depths and decreased with increasing depth. For species with a similar depth distribution, those with the lowest metabolic rate showed the greater heat tolerance. (ST)

<33>
Boehlert, G.W., University of California, San Diego, CA

Physiological and Morphological Adaptations in the Surface-to-Benthic Migration of SEBASTES DIPLOPROA (Pisces, Scorpaenidae).
Ph.D. Thesis, University of California, 188 pp. (1977)

The rockfish SEBASTES DIPLOPROA inhabits temperate surface waters off the California coast for about one year before migrating to the benthic juvenile and adult habitat at depths of 150 to 300 meters. Certain physiological changes occur prior to the migration. Pelagic prejuveniles were acclimated to photoperiod-temperature regimes in the laboratory. Growth rate of the acclimated fish decreased at sizes greater than 40 mm SL under surface temperature conditions, suggesting a drop in the temperature of optimum growth. Respiratory rates of acclimated fish were used to develop a model of expected respiratory rate for prejuveniles based on acclimation and test temperatures, photoperiod, and weight. Oxygen consumption was proportional to temperature, but inversely proportional to photoperiod. Metabolic rate compensation was evident. Respiratory rates at 10, 15, and 20 C were determined monthly for field-acclimatized prejuveniles and compared to the rates predicted by the model. During the migratory season, the rates at 10 C exceeded those predicted by the model. Lowered thermal sensitivity during these months was evident in Q10 values, which were close to model-predicted values for acclimated temperature change. The observed changes suggest that this species anticipates the change in environmental temperature prior to its migration and adjusts its respiratory metabolism through metabolic rate compensation. (Auth)(MU)

<34>
Boehlert, G.W., Scripps Institution of Oceanography, La Jolla, CA

Changes in the Oxygen Consumption of Prejuvenile Rockfish, SEBASTES DIPLOPROA, Prior to Migration from the Surface to Deep Water.
Physiol. Zool., 51, 56-67 (1978)

Prejuvenile SEBASTES DIPLOPROA migrate from temperate surface waters of the California current region to cold, deep waters inhabited by juveniles and adults. Based on results from laboratory-acclimated prejuveniles, metabolic rates were proportional to test temperature, acclimation temperature, and weight and inversely proportional to photoperiod. A multiple regression model was constructed using the factors above to predict respiratory rates in field-acclimatized prejuveniles. During the migratory season (May-September), respiratory rates measured at 10 C were much higher than values predicted by the model. The Q10 values between respiratory rates measured at 10 and 20 C were low during May to August, closer to the value predicted by the model for acclimated rather than acute temperature change. Results suggest that surface prejuveniles develop metabolic rate compensation to the lower temperatures of the benthic habitat prior to migration. (Auth)(MU)

<35>
Bogdanova, I.S., Leningrad University, USSR

The Growth and Development of the Larvae of Kuben Inconnu, STENODUS LEUCICHTHYS NELMA, under Conditions of Varying Temperatures and Feeding Regimes.
Jour. Ichthyol., 17, 582-590 (1977)

The external morphological features, the histologic structure of the digestive system and the rate of feeding of the larvae of the inconnu, STENODUS LEUCICHTHYS NELMA, at temperatures of 11.4 and 3.8 C are considered. The influence of delay in the change-over of the larvae to exogenous feeding and starvation has also been studied at these temperatures. It is demonstrated that a reduced temperature has more of a negative effect on the development of the inconnu, in particular on its digestive system, than a delay in its change-over to exogeneous feeding. (Auth)

<36>
Bonin, J.D., and J.R. Spotila, State University College at Buffalo, Department of Biology, Buffalo, NY

Temperature Tolerance of Larval Muskellunge (ESOX MASQUINONGY) and F_1 Hybrids Reared Under Hatchery Conditions.
Comp. Biochem. Physiol., 59A, 245-248 (1978)

Critical thermal maxima (CTM) of larval muskellunge (ESOX MASQUINONGY) and norlunge (ESOX MASQUINONGY females x E. LUCIUS males) were determined under hatchery conditions. Norlunge had a higher temperature tolerance and developed faster. CTM of larval norlunge (30.9 to 36.0 C, mean = 34.0 C) were significantly higher than those of muskellunge (29.9 to 35.6 C, mean = 32.8 C). Both fish exhibited a sharp decrease in CTM during swim-up, followed by a slow recovery period characterized by a general increase in CTM values. Both age and past thermal history had important effects on temperature tolerance of fry. Norlunge fry were better able to physiologically adjust to changing conditions than were muskellunge. (Auth)

<37>
Boothe, P.N., Stanford University, Stanford, CA

Chronic Toxicity and Interactions between P,P'-DDT, P,P'-DDD, P,P'-DDE and Pelagic Crustacean Larvae.
Ph.D. Thesis, Sanford University, 333 pp. (1978)

Prolonged static culture experiments were conducted using larval and adult brine shrimp (ARTEMIA SALINA) exposed to DDT associated with food or other particulate matter in the culture system. DDT exhibited a strong negative temperature coefficient of toxicity. It was 20 times more toxic at 5 C than at 27 C. In contrast, salinity stress only slightly changed DDT toxicity. Similar chronic toxicity tests were conducted with ARTEMIA exposed to DDD or DDE. The toxicities of both compounds were also inversely proportional to environmental

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<37> CONT.

temperature. Depending on temperature, DDT was 3 to 8 times and more than 10 times more toxic than DDD and DDE respectively. Cumulative DDT toxicity tests with larvae of the spot prawn (PANDALUS PLATYCEROS) gave results similar to those with ARTEMIA. Depending on the temperature, significant differential mortality of ARTEMIA was observed at body burdens of 0.2 to 2 ppm wet weight. PANDALUS larvae exhibited similar mortality at levels above 0.2 ppm. (ST)

<38>

Boothe, P.N., Texas A&M University, College Station, TX

Effects of Temperature on the Chronic Toxicity of a Pesticide and Its Metabolites to ARTEMIA SALINA (L.).

Pharmacologist, 20, 185 (Abstract only) (1978)

DDT (dichlorodiphenyltrichloroethane) and its primary metabolites, DDD (dichlorodiphenyldichloroethane) and DDE (dichlorodiphenyldichloroethylene), are ubiquitous xenobiotics in the global biosphere. DDT exhibits a negative temperature coefficient of toxicity. A sensitive aquatic crustacean poikilotherm was used to study this unusual phenomenon and to see how temperature modified the toxicity of DDD and DDE. ARTEMIA were exposed to these compounds in their yeast food for three to nine weeks. DDT was about five times more toxic than DDD and ten times more toxic than DDE over the temperature range studied (5 to 27 C). DDT was more than three times more toxic at 10 than at 20 C. Enhanced metabolic detoxification of assimilated DDT at higher temperatures played a minor role in this relationship. The minimum toxic whole body DDT concentration at 10 C (0.3 ppm) was one-third that of the comparable body burden at 20 C (1 ppm). DDD and DDE exhibited a similar proportional relationship. The onset of DDT toxicity was most rapid at 20 C and decreased rapidly above and below this intermediate temperature. At least three interacting factors were apparently responsible for this relationship: (1) increase in DDT's efficacy with decreasing temperature; (2) increase in DDT uptake rate with increasing temperature; and (3) increase in lipid turnover rate at higher temperature. (Auth)

<39>

Bradford, J.M., and D.A. Burns, New Zealand Oceanographic Institute, Wellington, New Zealand

The Effects of the Marsden 'A' Thermal Power Station on the Marine Plankton.

NZOI Records (New Zealand), 3, 69-86 (1977)

Average ocean temperatures in the vicinity of Marsden 'A' (near Whangarei, New Zealand) were 15 C in August and 20 C in February. Nearer shore temperatures have been recorded slighlty higher (22.6 C). Maximum temperature reached by the cooling water as it passed through the condensers was 9.7 C above intake temperature. The highest effluent temperature was 3.8 C above that of the surrounding water. Mechanical stress was probably the most important factor causing damage to the planktonic organisms. No chlorine was being used at the time of sampling and the maximum temperature reached in the condensers (23.7 C) was probably within the range of tolerance of many animals as it only slightly exceeded observed summer temperatures. In mid-summer, thermal effects may be added to mechanical stress as a factor responsible for killing living matter in sea water entering the condensers. (MU)

<40>

Bradley, B.P., University of Maryland Baltimore County, Department of Biological Sciences, Catonsville, MD

Increase in Range of Temperature by Acclimation in the Copepod EURYTEMORA AFFINIS.

Biol. Bull., 154, 177-187 (1978)

The copepod, EURYTEMORA AFFINIS, was tested for its ability to recover from short exposures to high temperature (temperature tolerance). Animals kept at a warm temperature for several hours or days before the test increased in tolerance (acclimation). Females showed higher tolerance and acclimation than males. Temperature tolerance was greater at a higher salinity (13 ppt vs 0 ppt), but acclimation was not. Analogous tests were done at low temperatures. Acclimation to cold temperature also occurred, but more slowly. Sexual differences were less marked than for heat tolerance. When tested on the same animals, heat and cold tolerances seemed to be positively related traits. (Auth)

<41>

Branch, G.M., and R.C. Newell, University of Cape Town, Department of Zoology, Rondebosch, Cape Town, South Africa

A Comparative Study of Metabolic Energy Expenditure in the Limpets PATELLA COCHLEAR, P. OCULUS and P. GRANULARIS.

Marine Biol. (W. Ger.), 49, 351-361 (1978)

Oxygen consumption of three species of PATELLA was measured in air and water at various temperatures. Measurements at constant temperature over a full tidal cycle showed no tidal or light-dark rhythms. P. COCHLEAR (a low-shore species) had a moderate rate of respiration and a respiratory rate-temperature (R-T) curve which peaked at 20 C and formed a plateau between 20 and 32.5 C. P. OCULUS (a mid-shore species) had a high metabolic rate and a respiratory R-T curve which peaked at 32.5 C. P. GRANULARIS (an upper-shore species) had low Q10 values and a low R-T curve resulting in relative independence of temperature. The patterns of respiration in these three species were related to food availability. (MU)

<42>

Branford, J.R., University of Liverpool, Department of Marine Biology, Port Erin, Isle of Man

Incubation Period for the Lobster HOMARUS GAMMARUS at Various Temperatures.

Marine Biol. (W. Ger.), 47, 363-368 (1978)

The relationship between temperature and incubation period in HOMARUS GAMMARUS is estimated and a method of determining the temperatures which are required to obtain hatches at preselected times is given. Berried females were exposed to fluctuating temperature regimes, with average temperatures between 10.0 and 18.3 C. Incubation periods ranged between 3.6 and 9.5 months. The relationship between incubation period and the sum of monthly average temperatures was approximately linear, and can be used to calculate the temperature regime required to cause hatching at a preselected time. At 10.4 C, the annual average temperature in the North Irish Sea, the estimated incubation period is 11 months. Based on collections of berried females, a notational spawning date

<42> CONT.
of August 15 was adopted and used in the calculation of incubation periods. (ST)

<43>
Branford, J.R., University of Liverpool, Department of Marine Biology, Port Erin, Isle of Man, United Kingdom

The Influence of Daylength, Temperature and Season on the Hatching Rhythm of HOMARUS GAMMARUS.
Jour. Mar. Biol. Assn. U.K., 58, 639-758 (1978)

The release of larvae by female lobsters is confined to a few minutes at night, and is repeated at a similar time on each night over several weeks. The rhythm is shown to be partly controlled by an endogenous component in the female. Eggs in vitro have an exogenous, light-stimulated hatching rhythm, but are arhythmic in continuous light or darkness. In light/dark regimes the time of hatching is not influenced by daylength, but occurs sooner after sunset as temperature increases. The time when females perform their part of the hatching process in light/dark regimes is shown to depend on temperature, daylength and previous photoperiodic experience. A theoretical equation linking these variables is proposed and tested. In continuous darkness, the rhythm free-runs; for part of the year, the period of the rhythm is effectively independent of temperature, but for the remainder of the year, the length of the period is markedly temperature-dependent. (Auth)

<44>
Brannon, E.L., R.E. Nakatani, and L.R. Donaldson, University of Washington, Division of Marine Resources, Seattle, WA

Waste Heat Employment for Accelerated Rearing of Coho Salmon.
NOAA-77080304; WSG-TA 77-9, In Conference on Waste Heat Management and Utilization held in Miami Beach, FL, May 9-11, 1976; National Technical Information Service, Springfield, VA (1976)

Studies conducted at the College of Fisheries, University of Washington on the use of waste heat to accelerate growth of coho salmon (ONCORHYNCHUS KISUTCH) have shown that a year reduction in freshwater rearing can be induced, without altering the marine residence period of this species. The result of this strategy has been to reduce coho generation time from three to two years, with substantial savings in hatchery production costs and increased biomass return. Application of this concept is considered in utilization of industrial waste heat. (Auth)

<45>
Brenner, F.J., W.L. Cooper, and C.L. MacMone, Grove City College, Biology Department, Grove City, PA

Effect of Temperature and Ferric Hydroxide on the Embryonic and Protein Development of the Coho Salmon, ONCORHYNCHUS KISUTCH.
Proc. Penn. Acad. Sci., 50, 165-169 (1976)

Two protein fractions were separated by paper electrophoresis in embryonic coho salmon, ONCORHYNCHUS KISUTCH, incubated at 10 and 16 C, in the presence and absence of ferric hydroxide. Fluctuations in protein fractions were correlated with the different developmental stages. The sodium/potassium ratio increased at the same rate during development in both groups of coho incubated at 10 C. Embryonic mortality was related to increased temperature during development rather than to ferric hydroxide. (Auth)

<46>
Brett, J.R., Department of the Environment, Fisheries and Marine Service, Pacific Biological Station, Nanaimo, British Columbia, Canada

Feeding Metabolic Rate of Young Sockeye Salmon ONCORHYNCHUS NERKA, in Relation to Ration Level and Temperature.
Fish. Res. Bd. Can. Tech. Rep. No. 675, 43 p. (1976)

Preliminary observations were assembled on the daily metabolic rates of fingerling sockeye salmon when feeding. These showed a direct relation between rate of oxygen consumption and size of ration, at each of the temperatures studies (10, 15, and 20 C). Ration effect induced a maximum change at 20 C, from an average of 100 mg O2/kg/hr for free-swimming starved fish (close to standard metabolic rate) to 415 mg O2/kg/hr at maximum daily food-intake. The data are analyzed along with published records of standard metabolism to develop a predictive model in the form of isopleths of daily metabolic rate in relation to temperature and ration. The predicted rates are compared with published studies on hatchery-reared chinook salmon, and with other studies on fish where feeding metabolic rates have been recorded. In general these support the observations and concepts developed for sockeye salmon. (Auth)

<47>
Brittain, J.E., Zoological Museum, University of Oslo, Oslo, Norway

The Effect of Temperature on the Egg Incubation Period of TAENIOPTERYX NEBULOSA (Plecoptera).
Oikos, 29, 302-305 (1977)

Eggs of TAENIOPTERYX NEBULOSA (L.) were incubated in the laboratory at constant temperatures between 2 and 24 C and at field temperatures. A relationship, linear on logarithmic scales, was found between water temperature (in degrees C) and mean egg incubation period (Y days) for the temperature range 2 to 24 C. The relationship is given by the regression equation: Y = 313 T(E-1.03). Hatching success was low below 4 C and above 20 C. (Auth)

<48>
Broeze, R.J., Rensselaer Polytechnic Institute, Troy, NY

The Effects of Low Temperature on Growth, Survival, and Metabolism of Bacteria.
Ph.D. Thesis, Rensselaer Polytechnic Institute, Troy, NY, 135 pp. (1978)

The effects of temperature on viability and the rates of growth, respiration and DNA, RNA and protein synthesis by a variety of bacterial types were studied. The psychrotrophic bacteria (PSEUDOMONAS FLUORESCENS, PSEUDOMONAS 412, and VIBRIO FISCHERI PS-207) and the psychrophile (VIBRIO FISCHERI MP-1) grew after a rapid shift from their optimal temperature to 5 C, but only after an initial lag period. Complex patterns of DNA, RNA, and protein synthesis were observed during this initial lag period. The failure of the mesophiles (ESCHERICHIA COLI, PSEUDOMONAS ARIDOVORANS, and PSEUDOMONAS 412 (m-46) to grow at low temperature appeared to be due to diminished rates of protein synthesis. (Auth)

<49>
<49>
Brooks, A.S., and G.I. Seegert, The University of Wisconsin-Milwaukee, Center for Great Lakes Studies and Department of Zoology, Milwaukee, WI

A Preliminary Look at the Effects of Intermittent Chlorination on Selected Warmwater Fishes.
Conf-771070: In Water Chlorination: Environmental Impact and Health Effects, Volume 2, R.L. Jolley et al. (Eds.), Proceedings of the Second Conference on the Environmental Impact of Water Chlorination, Gatlinburg, TN, October 31-November 4, 1977. Ann Arbor Science, Ann Arbor, MI (pp. 95-109), 909 pp. (1977; 1978)

Intermittent chlorination bioassays were carried out at test temperatures of 10, 20 and 30 C on five species of freshwater fish. Each exposure was conducted under static conditions, and followed a square wave pattern in that the chlorine concentration increased for 5 min, remained nearly constant for 30 min and then decreased for 5 min to zero following addition of sodium thiosulfate to the test chambers. Chlorine doses (91-98% monochloramine) were calculated as average values based on amperometric titration measurements made at the beginning and end of the 30-min period. DPD titrimetric methods were used to calculate free chlorine, monochloramine and dichloramine concentrations. The fish were exposed four times, once every five hours. Between exposures and for two days afterward (during which time mortality was assessed) the fish were kept under constant-flow-recirculating conditions. For emerald shiners (NOTROPIS ATHERINOIDES; avg. wts. 1.55-1.73g, avg. length 63.69 mm), the LC50 values were 0.63, 051 and 0.35 mg/l TRC at 10, 20 and 30 C, respectively. Similar temperature related differences in monochloramine tolerance were seen for the common shiner (NOTROPIS CORNUTUS, 1.29-1.44g and 53-55 mm; LC50 values of 0.78, 0.59 and 0.45 mg/l at 10, 20 and 30 C), for the spotfin shiner (NOTROPIS SPILOPTERUS; 1.24-1.31 g, 51-54 mm; LC50 values of 0.650, 0.595, 0.405 mg/l at 10, 20 and 30 C) and for the carp (CYPRINUS CARPIO, 5.07-8.06 g, 72-85 mm, LC50 values of 2.37, 1.82 and 1.50 mg/l at 10, 20 and 30 C, respectively). Mortalities occurred more rapidly at the higher test temperatues, but the authors noted that this effect appears to decrease with longer or more frequent exposures. The safe factor for all fish species tested, based on the difference between LC50 and zero mortality values, averaged 0.77. The authors noted that this was slightly higher than the 0.5 value calculated by them in previous studies. (DMO)

<50>
Broom, M.J., and J. Mason, Portsmouth Polytechnic, Marine Resources Research Unit, Portsmouth, England; Marine Laboratory, Torry, Aberdeen, Scotland

Growth and Spawning in the Pectinid CHLAMYS OPERCULARIS in Relation to Temperature and Phytoplankton Concentration.
Marine Biol. (W. Ger.), 47, 277-285 (1978)

The relationship between growth and spawning cycle of queen scallops and two environmental variables, temperature and food, are examined. The data suggest that one major growth ring was formed per year, although disturbance bands were also present. Lamellae (daily growth increments) were laid down most regularly when temperature was moderately high and food availability was good. Very slow growth occurred at water temperatures of 5 to 6 C. (ST)

<51>
Broughton, N.M., and N.V. Jones, Hull University, Department of Zoology, England

An Investigation into the Growth of O-Group Roach, (RUTILUS RUTILUS L.) with Special Reference to Temperature.
Jour. Fish Biol., 12, 345-357 (1978)

The growth of 0-group roach in a chalk-fed river was traced over six seasons and the growth compared to that in a nearby gravel pit. The growth rate, the daily weight and the condition of the fish were all highest during the summer, falling to a minimum over the winter period and rising again in the spring. Considerable yearly variation in the growth of roach in the river was observed and correlated with water temperatures above 14 C. It is suggested that water temperature, acting through the food supply, is the dominant factor governing growth. The hot summer of 1976 appears to have resulted in excellent growth of roach in both habitats. (Auth)

<52>
Brown, R.J., National Technical Information Service, Springfield, VA

Thermal Pollution. Part 2. Biological Effects. Vol. 2. 1974 - February 1978: A Bibliography with Abstracts.
NTIS/PS-78/0172, 208 pp. (1978)

Abstracts covering the effects of heated effluents on fish, shellfish, microorganisms, and plants in both fresh and salt water are presented, including the effects on growth, ecology, metabolism, heat tolerance, and productivity. The effluent sources are both power and industrial plants. This updated bibliography contains 208 abstracts, 39 of which are new entries to the previous edition. (Auth)

<53>
Bryan, B.B., University of Virginia, Charlottesville, VA

The Ecology of the Marine Cladocera of Lower Chesapeake Bay.
Ph.D. Thesis, University of Virginia, 111 pp. (1977)

A two-year zooplankton survey of lower Chesapeake Bay was conducted from August 1971 to August 1973. Marine cladocera comprised from 36 to 68% of the total zooplankton. Of the six species of marine cladocera found, PODON POLYPHEMOIDES was most eurythermal and euryhaline, being found in abundance at temperatures of 7 to 26 C and salinities of 11.5 to 27 ppt. It was found in all months of the year with a peak occurrence in May and a smaller peak in January. Peak densities always followed periods of rapidly changing temperatures. PODON LEUCKARTI was found only near the Bay mouth. Its appearance was restricted to the month of May. PODON INTERMEDIUS occurred only in the Bay mouth from July to September at 18.3 to 26.4 C and a minimum salinity of 20.42 ppt. EVADNE NORDMANNI occurred from late winter through June, with a peak in May. Highest concentrations were at the bay mouth at 15 to 19 C and 17 to 26 ppt salinity. EVADNE TERGESTINA and PENILIA AVIROSTRIS appeared in great densities at some stations. Densities of both species were greatly reduced by September and they disappeared in October, 1971. They reappeared in late summer the following two years, but at lower densities. (ST)

<54>
Burnside, D.F., Not given

Upper Lethal Temperature of Two Species of FUNDULUS as a Function of Acclimation Temperature.
Jour. Elisha Mitchell Sci. Soc., 93, 100-101 (Abstract only) (1977)

FUNDULUS MAJALIS and F. HETEROCLITUS were acclimated for two weeks to temperatures of 10, 20, and 30 C. At the end of the two weeks, the temperature was increased 5 C per hour to 35 C. The rate of increase in temperature was then decreased to 2 C per hour until the point of death was determined by observing the cessation of opercular movements. The upper lethal temperature (ULT) of F. MAJALIS and F. HETEROCLITUS increased exponentially as a function of acclimation temperature. At 10 C (acclimation temperature), the ULT of F. MAJALIS was 37.2. It increased to 38.5 for an acclimation temperature of 20 C, and to 40.9 for an acclimation temperature of 30 C. The ULTs recorded for F. HETEROCLITUS were: 38.1 when acclimated to 10 C, 38.9 when acclimated to 20 C, and 41.7 when acclimated to 30 C. F. HETEROCLITUS had a slightly higher tolerance than F. MAJALIS for all acclimation temperatures. (Auth)

<55>
Bursey, C.R., Pennsylvania State University, Shenango Valley Campus, Sharon, PA

Temperature and Salinity Tolerance of the Mole Crab, EMERITA TALPOIDA (Say) (Crustacea, Anomura).
Comp. Biochem. Physiol., 61A, 81-83 (1978)

Adult EMERITA TALPOIDA were subjected to 25 temperature-salinity combinations within the range 5 to 35 C and 15 tc 65 g/l. E. TALPOIDA tolerated 15 to 65 g/l salinity at 20 C and below. Optimum salinity for survival at stressful temperatures was 40 g/L. Crabs transferred directly from one salinity to another experienced changes in osmoconcentration toward that of the new salinity. Temperature modified the rate of change toward the experimental salinity. Q values averaged 1.2. (Auth)

<56>
Buyanov, N.I., A.D. Rozhdestvenskaya, N.I. Laptev, and V.D. Stepanova, Polar Research and Planning Institute for Sea Fisheries and Oceanography (PINRO), Murmansk, USSR; Institute of Biophysics, USSR Ministry of Public Health, Moscow, USSR

The Use of Thermal Effluent from the Kola Atomic Power Station for the Rearing of Marketable Fish.
Jour. Ichthyol., 16, 996-1000 (1976)

Preliminary results of the rearing of rainbow trout (SALMO GAIRDNERI) in cages in the effluent of the Kola Atomic Power Station (USSR) are reported. Growth was intensive in summer at temperatures of 17 to 18 C, but was depressed at 22 to 23 C. Measurements of radioisotopes in the bottom sediments, the fish, and fish from a control area showed that there is no appreciable radioactive pollution in the region after one year of station operation. (ST)

<57>
Byrne, D.M., Ichthyological Associates, Inc., Absecon, NJ

Life History of the Spotfin Killifish, FUNDULUS LUCIAE (Pisces: Cyprinodontidae), in Fox Creek Marsh, Virginia.
Estuaries, 1, 211-227 (1978)

<54>

FUNDULUS LUCIAE was collected for a year at Fox Creek Marsh along the York River, Virginia. Habitat characteristics, food habits, fecundity, spawning season, growth and development, behavior, species associations, and parasites of this killifish were studied. F. LUCIAE was present throughout the year in water temperatures ranging from 4 to 36 C. Spawning occurred in ten gallon aquaria at temperatures of 20 to 25 C. During the spawning season at the Marsh (mid-April to mid-August), water temperatures of 19 to 36 C were recorded. Eggs kept in fresh and brackish water at 20 to 25 C usually hatched in 12 to 16 days while those at higher salinities hatched much later. (MU)

<58>
Cadot, H.M., Jr., and R.L. Kaesler, The Harris Center for Conservation Education, Hancock, NH; University of Kansas, Department of Geology and Museum of Invertebrate Paleontology, Lawrence, KS

Magnesium Content of Calcite in Carapaces of Benthic Marine Ostracoda.
Univ. Kansas Paleontological Contrib., Paper 87, 23 pp. (1977)

Statistically significant differences in mean magnesium content of calcite in carapaces of benthic marine Ostracoda were found to occur among four superfamily groups and among regions of the carapace for each of the superfamily groups. Variation of water temperature was judged to be a significant source of variation in magnesium content at the superfamily level, independent of the rate of growth. Depth was imperfectly correlated with temperature and was not as highly associated with magnesium content as was temperature. (ST)

<59>
Cairns, J., Jr., A.L. Buikema, Jr., A.G. Heath, and B.C. Parker, Virginia Polytechnic Institute and State University, Department of Biology and Center for Environmental Studies, Blacksburg, VA

Effects of Temperature on Aquatic Organism Sensitivity to Selected Chemicals.
VPI-VWRRC-BULL 106, 88 pp. (1978)

This research evaluated the effect of temperature on the sensitivity of food web organisms to selected chemicals. Test organisms included planktonic algae (CYCLOTELLA MENEGHINIANA, SCENEDESMUS QUADRICAUDA, CHLAMYDOMONAS sp., and LYNGBYA sp.), zooplankton (DAPHNIA PULEX, DAPHNIA MAGNA, and CHILOMONAS PARAMECIUM), microbenthos (AEOLOSOMA HEADLEYI, PHILODINA ACUTICORNIS, and LEPIDODERMELLA sp.), macrobenthos (NITROCRIS sp.), and fishes (SALMO GAIRDNERI, NOTEMIGONUS CRYSOLEUCUS, LEPOMIS MACROCHIRUS, CARASSIUS AURATUS, and ICTALURUS PUNCTATUS). The chemicals used in this research were copper, zinc, chromate, chlorine, cyanide, and phenol. The sensitivity of the test organisms to these chemicals was studied over a temperature range of 5 to 35 C. The specific temperatures studied varied with each species. The results of this research indicate that there is considerable variation in the sensitivity of each species, and this variation depends on the chemical and the test temperature. Generally, the algal responses to the temperature and chemicals varied depending on the thermal sensitivity of the algal species in question. The invertebrates usually exhibited the classic response of increased sensitivity to chemicals at higher temperatures. Two notable exceptions to

<59>
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this observation were the "reverse" response of temperature and cyanide to the oligochaete AEOLOSOMA and the temperature independent response of the invertebrates to phenol. For fish, survival was enhanced (a) at low concentrations of chemicals and high temperatures and (b) at high chemical concentrations and low temperatures. Some fish species had chemical threshold concentrations which were not influenced by temperature. (Auth)

<60>
Campbell, C.M., and P.S. Davies, University of Glasgow, Department of Zoology, Glasgow, Scotland

Temperature Acclimation in the Teleost BLENNIUS PHOLIS: Changes in Enzyme Activity and Cell Structure.
Comp. Biochem. Physiol., 61B, 165-167 (1978)

The effect of thermal acclimation on the activity of liver enzymes of BLENNIUS PHOLIS and on the ultrastructure of the liver was studied. Significant increases in the activities of SDH and G6PDH, but not of LDH were found after cold acclimation. Electron micrograph measurements suggested that cold acclimation resulted in an increase in the size of liver cells and their nuclei, and in the number, but not the size of liver mitochondria. (Auth)

<61>
Cannon, T.C., S.M. Jinks, L.R. King, and G.J. Lauer, Ecological Analysts, Inc, Middletown, NY

Survival of Entrained Ichthyoplankton and Macroinvertebrates at Hudson River Power Plants.
In Fourth National Workshop on Entrainment and Impingement, L.D. Jensen (Ed.). EA Communications, Melville, NY, (pp. 71-90), 424 pp. (1978)

Field and laboratory studies simulating the effects of entrainment of macroinvertebrates and young fish were performed at Hudson River power plants from 1975 through 1977. Field studies provide the means for predicting entrainment-induced mortality from both mechanical and thermal stresses. Laboratory studies of thermal stress depict the specific response to the thermal component of entrainment. Tolerance of the organisms tested under conditions simulating entrainment at Hudson River power plants was generally high for total temperatures less than 33 C for summer ambient conditions. Thresholds were reached for the macroinvertebrate NEOMYSIS at about 34 C, GAMMARUS at 37 C, and CHAOBORUS at about 40 C. For fish, including the striped bass, white perch, and Clupeidae, the larval threshold is about 33 C. Mortality observed below expected thermal threshold temperatures is probably attributable to mechanical effects. Reductions in survival observed below 30 C were generally from 0% and 30%. Observed survival declines rapidly at temperatures consistent with threshold temperatures observed in thermal bioassay studies for 30-40 minute exposures to heated water. Based on the results of these studies it is apparent that in most cases entrainment mortality is limited to low levels (0%-30%) of mechanical-induced mortality when discharge temperatures are maintained below threshold levels. The significance and extent of potential entrainment mortality is thus a function of the extent of threshold conditions existing at each of the power plants. (Auth)

<62>
Carter, S.R., NALCO Environmental Sciences, Lincoln, NB

Macroinvertebrate Entrainment Study at Fort Calhoun Station.
In Fourth National Workshop on Entrainment and Impingement, L.D. Jensen (Ed.). EA Communications, Melville, NY, (pp. 155-170), 424 pp. (1978)

Drifting macroinvertebrates entrained through the condenser cooling water system at Fort Calhoun Station on the Missouri River (near Blair, Nebraska) were studied from October 1973 through June 1977. Samples were collected twice monthly from the station's intake and discharge areas and immediately analyzed for viability. The mechanical effects of entrainment were analyzed on 16 dates when samples were collected during periods of station shutdown. Differential mortality (discharge minus intake mortality) for the drift assemblage ranged from 0.0 to 18.2% and averaged 7.7% during the study period. Thermal stress (delta T of 8 to 11 C) was the primary cause of entrainment mortality for drifting macroinvertebrates. Differential mortality for the drift assemblage averaged 3.4% when the station was not generating electricity, and there was no transfer of heat across the condenser. During periods when heat was being exchanged across the condenser, differential mortality averaged 8.6%. The total impact of entrainment was dependent on the distribution of drift organisms in the river and the fraction of total river flow diverted for cooling. Fort Calhoun Station used 1.2-4.9% of the Missouri River flow for cooling purposes. Assuming uniform drift distribution, mortality for the total drift assemblage passing the station increased an average of 0.2% as a result of station operation. (Auth)

<63>
Casterlin, M.E., and W.W. Reynolds, Pennsylvania State University, Biology Department, Wilkes-Barre, PA

Behavioral Fever in Crayfish.
Hydrobiologia (Den.), 56, 99-101 (1977)

Crayfish (CAMBARUS BARTONI) were tested individually in an electronic shuttlebox thermoregulatory device which allowed them to control water temperature, and thereby their body temperature, by their movements. Crayfish which initially selected 22.1 C water increased their preferred temperature by 1.8 C following injection of killed bacteria (AEROMONAS HYDROPHILA) into the gill cavity. This behavioral fever appears similar to that of vertebrates, and may enhance host defense reactions against pathogens. (Auth)

<64>
Caulton, M.S., University of Rhodesia, Hydrobiology Research Unit, Salisbury, Rhodesia

The Importance of Habitat Temperatures for Growth in the Tropical Cichlid TILAPIA RENDALLI Boulenger.
Jour. Fish Biol., 13, 99-112 (1978)

Growth of TILAPIA RENDALLI, a native of shallow tropical freshwater systems of Africa, is enhanced by its marked daily movement into warm shallow water during the day and return to cooler, deeper water at night. Growth is predicted to be optimal if the fish occupy water with a temperature of 30 C during the day, but retire to a habitat with temperatures of 18 C at night. The

<64> CONT.
reasons for this phenomenon are discussed using a bioenergetic model incorporating measurements of feeding intensity, metabolic energy demands, and assimilation efficiencies at temperatures ranging from 18 to 34 C. (ST)

<65>
Caulton, M.S., Rhodes University, Institute for
Freshwater Studies, Zoolcgy Department,
Grahamstown, South Africa

The Effect of Temperature and Mass on Routine Metabolism in SAROTHERODON (TILAPIA) MOSSAMBICUS (Peters).
Jour. Fish Biol., 13, 195-201 (1978)

A reappraisal of oxygen uptake by SAROTHERODON MOSSAMBICUS was undertaken using a continuous flow respirometer. Measurements were obtained over the temperature range 16 C tc 37 C for fish weighing between 10 and 150 g. Routine metabolic energy expenditure was described by a given equation. (Auth)(MU)

<66>
Caulton, M.S., University of Rhodesia,
Hydrobiology Research Unit, Division of
Biological Sciences, Salisbury, Rhodesia

The Effect of Temperature on Routine Metabolism in TILAPIA RENDALLI Boulenger.
Jour. Fish Biol., 11, 549-553 (1977)

Using a continuous flow respirometer it was shown that young TILAPIA RENDALLI had three distinct phases of oxygen consumption over the temperature range of 17 to 40 C. In the first phase (17 to 28 C) the metabolic energy demand followed the normal logarithmic increase with increasing temperature. Between 28 and 37 C the increased oxygen uptake was suppressed and showed a relatively small increase with increasing temperature. This feature was believed to be a significant energy saving function important to the growth of these fish which feed in the warm eulitoral margins of lakes during the day. The final phase shows a return to the original logarithmic increase in cxygen consumption. These results were related to, and compared with, actual changes in biomass at various temperatures and the thecretical and actual biomass changes were found to compare favourably. (Auth)

<67>
Champ, P., Ecole Normale Superieure, Laboratoire
de Zoologie, Cedex, France

Population Dynamics of a Sessile and Thermophile Rotifer (SINANTHERINA SOCIALIS) in the Presence of Thermal Pollution.
Arch. Hydrobiol. (Ger.), 83, 213-231 (1978)

The sessile, colonial rotifer SINANTHERINA SOCIALIS (Linnaeus) has been found in great numbers in the river Loire every summer for some years. Population dynamics during the year was investigated by sampling with artificial substrata. The data collected in rearing showed that the species can grow between 18 and 34 C, with a maximum birth rate at 28 C. In the field, the birth rates were estimated with Edmondson's method using the mean number of eggs per female in the samples. In summer they decrease when the temperature and the population density increase: they are likely limited by the quantity of available food (diatoms). In fall, they increase with temperature and population density, the main limiting factor being temperature. Below the heated effluent of the nuclear power plant of Chinon, the season of presence of SINANTHERINA is longer than upstream, and population densities are higher. But the secondary productivity, likely limited by the quantity of food, does not reach greater values. Although the thermal pollution lengthens the season when SINANTHERINA SOCIALIS can grow, the exceptional densities of this rotifer are the consequence of the eutrophication of the river. (Auth)

<68>
Chan, D.K.O., and N.Y.S. Woo, University of Hong
Kong, Department of Zoology, Hong Kong

The Respiratory Metabolism of the Japanese Eel, ANGUILLA JAPONICA: Effects of Ambient Oxygen, Temperature, Season, Body Weight, and Hypophysectomy.
Gen. Comp. Endocrin., 35, 160-168 (1978)

The oxygen consumption rate of the eel was oxygen dependent at low environmental pO2 levels. The critical pO2 was 88 torr at 10 C, rising to 128 torr at 32 C. In acute temperature changes, the Q10 value for eels acclimated to 19 C was linear from 13 to 30 C and was 3.19. Eels acclimated to the low and high temperatures of winter and summer showed temperature compensation (Q10= 1.39): relatively constant metabolic activity was maintained throughout the year. (ST)

<69>
Chang, S.L., U.S.E.P.A., Environmental Research
Center, Cincinnati, OH

Resistance of Pathogenic NAEGLERIA to Some Common Physical and Chemical Agents.
Appl. Environ. Microbiol., 35, 368-375 (1978)

Resistance of pathogenic NAEGLERIA to drying, low and high temperature, and two halogens was studied. Drying made trophozoites nonviable instantaneously: cysts were nonviable in less than five min. Trophozoites degenerated in several hours at temperatures below 10 C and survived about 30 min at 51 C. Cysts survived several times longer. Cyst destruction rate by free chlorine and iodine conformed to first-order kinetics. (ST)

<70>
Chapelle, S., University of Liege, Laboratoire de
Biochemie generale et comparee, Liege,
Belgium

The Influence of Acclimation Temperature on the Fatty Acid Composition of an Aquatic Crustacean (CARCINUS MAENAS).
Jour. Exp. Zool., 204, 337-346 (1978)

Crabs (CARCINUS MAENAS) were acclimated to temperatures of 7, 14, and 27 C and the fatty acid pattern of lipids from muscle, gills and hepatopancreas were determined. There was an overall tendency for the degree of unsaturation of fatty acids to decrease with an increase in acclimation temperatures. The greatest differences were observed in the relative content of C 16:0, C 16:1, C 18:1, C 20:5, and C 22:6 fatty acids. It is suggested that acclimation involves the ability to control the degree of unsaturation of cellular lipids in order to maintain a specific liquid-crystalline state of biomembranes and to check the activity of certain enzymes implicated into lipoproteins of the cellular membranes. A significant enhancement of degree of unsaturation of the phophatidylethanolamine and of the phosphatidylcholine was noted at lower temperatures. No or less pronounced changes occurred in triglycerides, phosphatidylserine and phosphatidylinositol. It is suggested that the acyltransferases,

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catalysing the conversion of lysophospholipid into phospholipid have an important regulatory role in the maintenance of a specific fatty-acid pattern of principal phospholipids. (Auth)

<71>
Cherry, D.S., R.C. Hoehn, S.S. Waldo, D.H. Willis, J. Cairns, Jr., and K.L. Dickson, Virginia Polytechnic Institute and State University, Blacksburg, VA

Field-Laboratory Determined Avoidances of the Spotfin Shiner and The Bluntnose Minnow to Chlorinated Discharges.
Water Res. Bull., 13, 1047-1055 (1977)

The responses of the spotfin shiner (NOTROPIS SPILORTERUS) and bluntnose minnow (PIMEPHALES NOTATUS) to intermittent chlorine discharges from a fossil fuel power plant in the New River were investigated by seine collections in the chlorinated discharge channel, and chlorine avoidances were obtained in a field laboratory at the power plant in Glen Lyn, Virginia. No fish were captured by seine during chlorination periods when the total chlorine (TCR) and free chlorine (FCR) residuals were, respectively, 0.46 and 0.27 mg/l or higher at river water temperatures of 12 C or less. For collections made between eight-hour chlorination periods, the number of fish was reduced by approximately 50% at 0.20 and 0.06 mg/l TCR and FCR, respectively. Significant (0.05 level) laboratory avoidances occurred at 0.10 to 0.20 mg/l TCR (0.03 to 0.14 mg/l FCR) for both species when exposed to increasing TCR concentrations of 0.10, 0.20, 0.30 and 0.40 mg/l. Responses varied with acclimation temperature (6, 12, 18 and 24 C) with no consistent trends between species. When exposed to a constant TCR concentration during any one test (0.14, 0.18 and 0.26 mg/l for the spotfin shiner, and 0.11 and 0.17 mg/l for the bluntnose minnow), significant avoidances were observed at 0.26 and 0.17 mg/l for each species, respectively. In all laboratory trials, occurrence or residence times decreased with increasing chlorine concentration, with residence times as high as 64.7% at 0.10 mg/l TCR and as low as 8.3% at 0.40 mg/l being observed. (Auth)

<72>
Cherry, D.S., S.R. Larrick, K.L. Dickson, and J. Cairns, Jr., Virginia Polytechnic Institute and State University, Center for Environmental Studies, Blackburg, VA

Response of Eurythermal and Stenothermal Fish Species to Chlorinated Discharges.
Trace Subst. Environ. Health, 11, 413-418 (1977)

Smallmouth bass (MICROPTERUS SALMOIDES), rockbass (AMBLOPLITES RUPESTRIS), and coho salmon (ONCORHYNCHUS KISUTCH) were exposed to several doubling concentrations of total residual chlorine (TRC) from 0.025 to 0.80 mg/l in a field laboratory. Avoidance responses were tested at acclimation temperatures of 6, 12, 18, 24, and 30 C. Initial avoidance responses occurred at higher TRC levels with increasing temperatures for smallmouth bass (0.05 to 0.20 mg/l TRC over the range 6 to 30 C) and coho salmon (0.05 to 0.10 mg/l over the range 6 to 18 C). Rockbass exhibited no avoidance response. After the first avoidance, bass and salmon showed less avoidance or attraction to higher concentrations of TRC. The avoidance response appeared to be influenced by the interaction of pH and temperature upon the dissociation of HOCl that comprised the TRC. The HOCl content calculated at each initial avoidance for these species was 0.020-0.024 mg/l for smallmouth bass and 0.014-0.016 mg/l for coho salmon from the lowest to highest acclimation level tested. (ST)

<73>
Childress, J.J., and M.H. Price, University of California, Department of Biological Sciences and Marine Science Institute, Santa Barbara, CA

Growth Rate of the Bathypelagic Crustacean GNATHOPHAUSIA INGENS (Mysidacea: Lophogastridae). 1. Dimensional Growth and Population Structure.
Marine Biol. (W. Ger.), 50, 47-62 (1978)

The intermolt interval of GNATHOPHAUSIA INGENS, measured in the laboratory at 5.5, 6.5, and 7.5 C increased with increasing size and decreased with increasing temperature. At 5.5 C it varied from 166 days for the smallest individuals to 253 for the oldest. The period of larval development in the marsupium of a female was estimated to be 530 days. The life span of females was estimated to be 2950 days with the onset of reproduction at 2400 days. This species has 13 instars, each with a distinct range of sizes. (ST)

<74>
Chung, K.S., Texas A&M University, Department of Wildlife and Fisheries Sciences, College Station, TX

The Salinity and Temperature Tolerance and the Growth of MACROBRACHIUM OHIONE (Smith) 1874 Reared in Laboratory Tanks.
Texas Jour. Sci., 28, 271-284 (1977)

The survival of shrimp reared in laboratory tanks at salinities of 4, 6, 10, and 13 ppt was observed. Temperature was allowed to fluctuate with atmospheric temperature. Survival decreased with increasing salinity from 87.5% in tapwater to 52.0% at 13 ppt. Most deaths occurred during molting at temperatures of 31.5 C and greater. (ST)

<75>
Clarke, W.C., Fisheries and Marine Service, Pacific Biological Station, Nanaimo, British Columbia, Canada

Growth of Underyearling Sockeye Salmon (ONCORHYNCHUS NERKA) on Diel Temperature Cycles.
Fisheries and Marine Service Tech. Rep. No. 780 (1978)

Individual specific growth rates were measured for 42 days at five constant temperatures ranging from 7.5 to 17.5 C and two diel thermocycles of 7-13 C and 5-15 C. At constant temperature, there was a linear increase in growth rate over the range 7.5-17.5 C. Both thermocycles had a mean of 10 C, but growth was greater on the 5-15 C cycle. It is suggested that cycling temperature regimes might provide a more cost-effective method for accelerating growth of salmon than does the present method of heating water to a constant temperature. (Auth)

<76>
Clarke, W.C., J.E. Shelbourn, and J.R. Brett, Department of Fisheries and Environment, Pacific Biological Station, Nanaimo, British Columbia, Canada

Growth and Adaptation to Sea Water in 'Underyearling' Sockeye (ONCORHYNCHUS NERKA) and Coho (O. KISUTCH) Salmon Subjected to

<76> CONT.
Regimes of Constant or Changing Temperature and Day Length.
Can. Jour. Zool., 56, 2413-2421 (1978)

Growth and hypoosmoregulatory ability of 'underyearling' sockeye and coho were studied in relation to the influence of constant as well as changing temperature and day length. Both environmental factors influenced growth and osmoregulatory performance. Temperature controlled the rate of response to photoperiod so that changes in growth rate caused by photoperiod treatments were apparent sooner at high temperatures than lower ones. Changing temperatures did not alter the final length or weight achieved in comparison with a constant temperature of the same mean. The sensitivity of the fry to photoperiod varied seasonally. The characteristics of photoperiod which formed the most important cues were direction of change and rate of change of day length. It is concluded that artificial photoperiod treatments are not required to produce 'underyearling' sockeye smolts in spring, provided that water temperatures are sufficient to allow growth to weight of 3-4 g. However, coho smoltify at a larger size and thus would require a substantially greater thermal input to produce 'underyearling' smolts in spring. (Auth)

<77>
Cloern, J.E., Washington State University,
Department of Zoology, Pullman, WA

Effects of Light Intensity and Temperature on CRYPTOMONAS OVATA (Cryptophyceae) Growth and Nutrient Uptake Rates.
Jour. Phycol., 13, 389-395 (1978)

Specific growth rate of CRYPTOMONAS OVATA var. PALUSTRIS Pringsheim was measured in batch culture at 14 light-temperature combinations. Both the maximum growth rate and optimum light intensity fit an empirical function that increased exponentially with temperature up to an optimum then declined rapidly as temperature exceeded optimum. Incorporation of these functions into Steele's growth equation gives a good estimate of specific growth rate over a wide range of temperature and light intensity. Rates of phosphate, ammonium and nitrate. Uptake were measured separately at 16 combinations of irradiance and temperature. Following a spike addition of all, starved cells initially took up nutrient at a rapid rate. This transitory surge was followed by a period of steady, substrate-saturated uptake that persisted until external nutrient concentration fell. Substrate-saturated nitrate-uptake proceeded at very slow rates in the dark and was stimulated by both increased temperature and irradiance; ammonium-uptake apparently proceeded at a basal rate at 8 and 14 C and was also stimulated by increased temperature and irradiance. Rates of ammonium-uptake were much higher than nitrate-uptake at all light-temperature combinations. Below 20 C, phosphate-uptake was more rapid in dark than in light, but was light enhanced at 26 C. (Auth)

<78>
Cloutman, D.G., Duke Power Company, Environmental
Science Unit, Huntersville, NC

Abundance of CLEIDODISCUS PRICEI Mueller (Monogena: Dactylogyridae) on the Flat Bullhead, ICTALURUS PLATYCEPHALUS (Girard), in Lake Norman, North Carolina.
Jour. Parasitol., 64, 170-172 (1978)

The abundance of CLEIDODISCUS PRICEI Mueller, a common gill parasite on ictalurid catfishes was studied on flat bullhead, ICTALURUS PLATYCEPHALUS (Girard), taken from Lake Norman (North Carolina), which receives thermal discharge from the Marshall Steam Station. Except for a small peak in December at 10 C, intensity of C. PRICEI was moderate to low during the fall, winter, and early spring. The population increased rapidly to peak abundance in May and remained moderately high through July at temperatures from 18 to 24 C. When water temperatures dropped to less than 10 C in January and February, the C. PRICEI population also declined. The cold temperatures apparently retarded parasite growth and reproduction in spite of the lack of an immune response in the host. The increase of C. PRICEI from May through July coincided with flat bullhead spawning. The decline of C. PRICEI abundance during August through November represented a time of high host resistance although temperatures were high enough for parasite growth and reproduction. (MU)

<79>
Cole, R.A., and J.E. Kelly, Michigan State
University, Department of Fisheries and
Wildlife, East Lansing, MI

Zoobenthos in Thermal Discharge to Western Lake Erie.
Jour. Water Poll. Control Fed., 50, 2509-2521 (1978)

The abundance and diversity of benthic macroinvertebrates were sampled in and near the thermal discharge from the once-through cooling system of a large power plant on western Lake Erie. Over a five year period we sampled the zoobenthos, oxygen, temperature and sedimentary particle size, carbon, and nitrogen at nine sites in the cooling system and adjacent reference areas in western Lake Erie. The benthos was comprised almost entirely of Tubificidae (tube worms) and Chironomidae (midges). Abundance in the lake was positively correlated with the amount of silt and clay in the sediments except where the bottom sediments were heated by the thermal discharge. Benthic abundance and diversity declined in the thermal discharge, possibly in response to intensified predation from fishes attracted to the heated water. (Auth)

<80>
Coles, S.L., and P.L. Jokiel, Hawaii Institute of
Marine Biology, Kaneohe, HI

Synergistic Effects of Temperature, Salinity and Light on the Hermatypic Coral MONTIPORA VERRUCOSA.
Marine Biol. (W. Ger.), 49, 187-195 (1978)

Temperature tolerance in the reef coral MONTIPORA VERRUCOSA was affected by salinity and light. A critical maximum temperature between 32 and 33 C was indicated at salinities of 30 ppt and above. At 20 and 25 ppt survival of elevated temperature was sharply reduced, especially if exposed specimens were held in full sunlight. In long term growth experiments, high light intensity caused substantial loss of zooxanthellar pigment, higher mortality rates, reduced carbon fixation, and lowered growth rate at both upper and lower sublethal temperatures, 20 and 28 C. Results of all experiments indicated an optimum temperature for this species near 26 C. (ST)

<81>
Coles, S.L., P.L. Jokiel, and C.R. Lewis,
Hawaiian Electric Company, Honolulu, HI;

<81>
<81> CONT.
University of Hawaii, Institute of Marine Biology, Kaneohe, HI

Thermal Tolerance in Tropical Versus Subtropical Pacific Reef Corals.
Pacifc Sci., 30, 159-166 (1976)

Upper lethal temperature tolerances of reef corals in Hawaii and at Enevetak, Marshall Islands, were determined in the field and under controlled laboratory conditions. Enevetak corals survived in situ temperatures of nearly 34 C, whereas 32 C was lethal to Hawaiian corals for similar short-term exposures. Laboratory determinations indicate that the upper thermal limits of Hawaiian corals are approximately 2 C less than congeners from the tropical Pacific. Differences in coral thermal tolerances correspond to differences in the ambient temperature patterns between geographic areas. (Auth)

<82>
Committee on Entrainment, Marine Sciences Research Center, State University of New York, Stony Brook, NY

On Selecting the Excess Temperature to Minimize the Entrainment Mortality Rate.
In Power Plant Entrainment: A Biological Assessment, Chapter 6, J.R. Schubel and B.C. Marcy, Jr. (Eds.). Academic Press, New York, (pp. 211-227), 271 pp. (1978)

Following assessment of thermal, chemical, and physical stresses experienced by entrained organisms at power plants with once-through cooling, a simple conceptual model for selecting an appropriate delta T to minimize the total mortality associated with all stresses combined was developed. Application of the analysis in the absence of information calls for using the highest excess temperature at which it is possible to operate the system. Although nearly all organisms passing through the system will die, the number entrained would be greatly reduced, thus minimizing the damage to the entire population at risk. At any given plant the most desirable combination of delta T and flow rate will probably change from season to season. (ST)

<83>
Connors, T.J., M.J. Schneider, R.G. Genoway, and S.A. Barraclough, Battelle Pacific Northwest Laboratories, Richland, WA

Effect of Acclimation Temperature on Plasma Levels of Glucose and Lactate in Rainbow Trout, SALMO GAIRDNERI.
Jour. Exp. Zool., 206, 443-449 (1978)

Baseline plasma glucose and lactate levels were determined in unstressed rainbow trout (SALMO GAIRDNERI) acclimated to 8, 12, and 16 C. The 8 C acclimated fish had the highest plasma glucose level (75.7 mg/dl), which is significantly greater than the 16 C acclimated fish (59.7 mg/dl) but not the 12 C fish (66.7 mg/dl). The plasma glucose levels of the 12 C and 16 C acclimated fish were not statistically different. The plasma lactate levels of 8 C fish (5.3 mg/dl), 12 C fish (4.2 mg/dl) and 16 C fish (5.3 mg/dl) were not significantly different. There was significant positive correlation between weight and length and significant negative correlation between plasma glucose and both weight and length. No other significant correlations between parameters were detected. (Auth)

<84>
Cooley, J.M., and C.K. Minns, Great Lakes Biolimnology Laboratory, Department of Fisheries and the Environment, Fisheries and Marine Service, Canada Centre for Inland Waters, Burlington, Ontario, Canada

Prediction of Egg Development Times of Freshwater Copepods.
Jour. Fish. Res. Bd. Can., 35, 1322-1329 (1978)

Available literature data on the relationship between freshwater copepod egg development time and temperatue were summarized and fitted where possible to Belehradek's temperature function D = a(T-alpha)(E+b) were D is development time , T is temperatue, a, b, and alpha are fitted constants. In the calanoids, and to a lesser extent cyclopoids, a and alpha were predictably related as were alpha and in situ egg hatching temperature (T sub H) when b was assumed to be constant for all copepods. This information was used to describe a simple procedure whereby a curve relating egg development and temperature could be constructed by only knowing T sub H and applying it to Belehradek's temperature function. (Auth)

<85>
Corkum, L.D., University of Toronto, Department of Zoology, Erindale College, Mississauga, Ontario, Canada

The Nymphal Development of PARALEPTOPHLEBIA ADOPTIVA (McDunnough) and PARALEPTOPHLEBIA MOLLIS (Eaton) (Ephemeroptera: Leptophlebiidae) and the Possible Influence of Temperature.
Can. Jour. Zool., 56, 1842-1846 (1978)

Nymphal development of PARALEPTOPHLEBIA ADOPTIVA and PARALEPTOPHLEBIA MOLLIS was studied in the West and East branches of the Credit River, Peel County, Ontario (Canada). Nymphs of P. ADOPTIVA were found only in the cooler water of the West branch. Based on head capsule width measurements, immature P. ADOPTIVA nymphs grew rapidly from September until December as water temperatures varied between 2.5 and 1 C. The nymphs continued to grow throughout the winter months but at a slower rate. Once temperatures increased, rapid growth resumed. Emergence was confined to a short period in mid-May when the maximum water temperatures reached about 15 C. P. MOLLIS nymphs occurred in both branches with nymphs in the West branch being significantly smaller than those of the East. No growth was observed for P. MOLLIS nymphs in winter. Once water temperatures increased in the spring (at about 5 C), growth resumed until June, leveled off during the summer, and resumed again in the autumn. (MU)

<86>
Cossins, A.R., M.J. Friedlander, and C.L. Prosser, University of Illinois, Department of Physiology and Biophysics, Urbana, IL

Correlations between Behavioral Temperature Adaptations of Goldfish and the Viscosity and Fatty Acid Composition of Their Synaptic Membranes.
Jour. Comp. Physiol., 120, 109-121 (1977)

Goldfish acclimated either to 5 C or to 25 C were transferred to the opposite temperature and the changes in behavioral resistance to high temperature and the fluidity and fatty acid composition of isolated synaptosomal membranes were followed during acclimation to the new temperature with the purpose of establishing some correlation. In 25 C-acclimated goldfish, hyperexcitability was induced at 34.5 C, loss of equilibrium at 37.6 C, and coma at 39.0 C. In 5 C-acclimated goldfish the corresponding

<86> CONT.

temperatures were 29.2, 32.0, and 33.0 C. Time to attain 75% of the final acclimated state after transfer was approximately four days at 25 C and 28 days at 5 C. It is concluded that during acclimation, behavior shows changes in resistance to heat which are related to synaptic block. These are correlated in direction and overall time course with viscosity of synaptosomes as dictated by changes in the saturation of membrane phospholipids. (Auth) (ST)

<87>

Coutant, C.C., Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN

A Working Hypothesis to Explain Mortalities of Striped Bass, MORONE SAXATILIS, in Cherokee Reservoir.
ORNL/TM-6534, Oak Ridge National Laboratory, 36 pp. (1978)

Bits of evidence regarding striped bass and Cherokee Reservoir are compiled into a speculative scenario that forms a conceptual basis for further research to determine the cause of recent fish mortalities. The fish mortalities, and the poor physiological states leading up to them, are hypothesized to be due to chronic heavy metal toxicity acting on fish that are abnormally crowded by temperature preference and avoidance of low dissolved oxygen into waters contaminated by drainage from zinc ores. The zinc ores (zinc and cadmium sulfide) are abundant in the region of the lower reservoir as both mine tailings and underlying dolomite rock formations. Immediate causes of death, e.g., catch-and-release fishing mortality or intolerance of high temperatures, may be traced to underlying heavy metal stresses acting on the energy reserves and physiological functions of the fish. (Auth)

<88>

Coutant, C.C., Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN

Determining the Ecological Effects of Power Plant Cooling.
In Lectures presented at the Fifth FAO/SIDA Workshop on Aquatic Pollution in Relation to Living Resources, Scientific and Administrative Basis for Management Measures, TF-RAS 34 (SWE) Suppl. 1, 459 pp. UN Food and Agriculture Organization, Rome (1978)

The ecological impacts from power plant cooling systems are reviewed. It is suggested that criteria for siting, design, and operation of generating stations with minimum ecological damage from the cooling systems can best be reached with a synthesis of field and laboratory research as this research relates specifically to the proposed power station and its ecological setting. Essential steps of environmental impact analysis are given. The analysis begins with detailed examination of the power plant for sources of potential ecological changes and leads to judgement of significance, usually determined by social impacts. (ST)

<89>

Coutant, C.C., Oak Ridge National Laboratory, Oak Ridge, TN

Representative Species Concept.
In Proc. Symp. The Integrity of Water (1975). U.S. Environmental Protection Agency, Washington, D.C. (pp. 149-154) (1977)

<86>

The author suggests using the Representative and Important Species (RIS) concept as a criterion for decisions about ecosystems based on water quality. Assumptions and criteria for suggesting RIS are discussed. By understanding life cycles and population dynamics of these species and by using predictive population dynamics models, standards that can be used by regulatory and conservation agencies can be formulated. (ST)

<90>

Craig, J.F., Freshwater Biological Asso., Windermere Laboratory, England

A Study of the Food and Feeding of Perch, PERCA FLUVIATILIS L., in Windermere.
Freshwater Biol., 8, 59-68 (1978)

As part of a study of the food and feeding habits of perch, PERCA FLUVIATILIS, in Windermere, the effect of water temperature on gastric evacuation was calculated from the drop in night-time stomach content weights when food intake was assumed to be zero. The rates ranged from 0.18 mg/h at a mean water temperature of 11 C in May to 0.35 mg/h at a mean water temperature of 17 C in July. (ST)

<91>

Creaser, E.P., Jr., and D.A. Clifford, Maine Department of Marine Resources, Research Laboratory, West Boothbay Harbor, ME

Salinity Acclimation in the Soft-Shell Clam, MYA ARENARIA.
Fishery Bull., 75, 225-229 (1977)

The relationship between temperature and acclimation of MYA ARENARIA to several salinities was investigated. Changes in shell liquor salinity were chosen as the criteria for the measurement of acclimation. Results indicated that a geometric relationship exists between temperature and salinity acclimation. The results are applicable to situations where MYA are harvested from one area and subjected to acclimation and depuration in another area. (ST)

<92>

Crippen, R.W., F.K. Fahmy, B. Seepersad, and A.H. Hayton, Beak Consultants Limited, Mississauga, Ontario, Canada

Impacts of Three Types of Power Generating Discharge Systems on Entrained Plankton.
In Fourth National Workshop on Entrainment and Impingement, L.D. Jensen (Ed.). EA Communications, Melville, NY, (pp. 191-202), 424 pp. (1978)

The effects of three types of discharge systems on Great Lakes plankton were investigated on behalf of Ontario Hydro. The studies incorporated both field observations and laboratory entrainment simulations to evaluate the responses of phytoplankton, zooplankton, and ichthyoplankton to onshore, offshore, and tempering discharge systems. An apparatus was designed to simulate the thermal regime experienced by plankton passing through once-through cooling systems. This apparatus enabled the simulation of a wide range of delta-Ts for each discharge system within a few hours. The main advantage of this system was the ability to evaluate the thermal effects of several combinations of entrainment regimes on subsamples from a single source. Primary production was used to measure the response of phytoplankton to the various laboratory simulations, whereas

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mortality was the criterion used to determine the effects on zooplankton and ichthyoplankton. A staining technique was developed in conjunction with this study to aid in live-dead determinations of zooplankton. During this investigation, efforts were made to determine both the immediate and the delayed impacts of entrainment on the organisms tested. A critical temperature range (ambient temperature plus delta-T) was found to cause a reduction in primary productivity for phytoplankton and increased mortality for zooplankton; however, no significant difference was measured among the three discharge systems tested. A seasonal change in temperature tolerance was noted for these two groups. Organisms collected during the summer tolerated higher total temperatures. Results of five species of fish larvae tested, however, indicated significant differences among the discharge systems. The tempering system was least harmful when the delta-T was greater than 15.5 C. Tolerance to onshore and offshore systems varied with species. (Auth)

<93>
Crumb, S.E., Ichthyological Associates, Inc.,
Middletown, DE

Macrobenthos of the Tidal Delaware River between
Trenton and Burlington, New Jersey.
Chesapeake Sci., 18, 253-265 (1977)

A study of the macrobenthos of the tidal Delaware River between Burlington and Trenton, N.J., included measurements of density and biomass for common species. Tubificidae (LIMNODRILUS) were dominant, comprising over 90% of all organisms taken in the three-year study period. Density seemed to be a function of water temperature (20 to 25 C, optimal) and was greatest in late spring and early summer. LIMNODRILUS spp. were present year round in all sediment types. Other common species were larval PROCLADIUS CULICIFORMIS (chironomidae) and CORBICULA MANILENSIS (asiatic clam). PROCLADIUS was most abundant in late summer just prior to and during emergence. The asiatic clam was in the process of colonizing the area and growth data have been calculated. One genus of dragonfly larvae (GOMPHUS) was found only near thermal discharges. Potential relationships between numbers and standing crop of the common organisms with sediment type and seasonal changes were explored. (Auth)(ST)

<94>
Dale, B., University of Oslo, Institute of Marine
Biology and Limnology, Oslo, Norway

Cysts of the Toxic Red-Tide Dinoflagellate
GONYAULAX EXCAVATA (Braarud) Balech from
Oslofjorden, Norway.
Sarsia, 63, 29-34 (1977)

Cysts of GONYAULAX EXCAVATA were isolated from marine surface sediments when overlying water temperature was 3 C. Cultures of the dinoflagellate growing at 15 C routinely formed non-motile stages when cooled below 5 C overnight. These temporary cysts formed motile cultures when returned to original culture conditions. Temporary cysts differed in stacture from the resting cysts and were not seen in sediments. (ST)

<95>
Dalela, R.C., S.R. Verma, and M.C. Bhatnagar,
D.A.V. College, Department of Zoology,
Muzaffarnagar, India

Biocides in Relation to Water Pollution Part I:
Bioassay Studies on the Effects of a Few
Biocides on Fresh Water Fish, CHANNA GACHUA.
Acta Hydrochim. Hydrobiol. 6, 15-25 (1978)

The median tolerance limits of four biocides, endrin, thiodon, malathion, and phosvel, were determined using the fish CHANNA GACHUA as the test organism. Endrin was the most toxic biocide with a 24 h TLm of 0.0076 mg/l. Phosvel was the least toxic. All biocides were more toxic at 35 C than at 24 C. (ST)

<96>
Dame, R.F., and F.J. Vernberg, University of
South Carolina, Belle W. Baruch Institute
for Marine Biology and Coastal Research,
Columbia, SC

The Influence of Constant and Cyclic Acclimation
Temperatures on the Metabolic Rates of
PANOPEUS HERBSTII and UCA PUGILATOR.
Biol. Bull., 154, 188-197 (1978)

The paper reports results of a study on the comparative influence of constant and cyclic acclimation temperatures on the respiratory metabolism of two intertidal crabs, PANOPEUS HERBSTII (mud crab) and UCA PUGILATOR (fiddler crab). Crabs were acclimated and tested at constant temperatures of 15, 20, 25, and 30 C and cyclic temperatures of 5 to 15, 10 to 20, 15 to 25, and 20 to 30 C. PANOPEUS exposed to the 15 to 25 C and UCA exposed to the 5 to 15, 10 to 20, and 15 to 25 C cycles had depressed responses compared to that of constant-temperature-acclimated crabs. Thus these experiments offer evidence that metabolic rate of intertidal organisms, as measured by oxygen consumption, is influenced differently by constant and cyclic temperature acclimation regimes. (ST)

<97>
Danks, H.V., Brock University, Department of
Biological Sciences, St. Catharines,
Ontario, Canada

Some Effects of Photoperiod, Temperature, and
Food on Emergence in Three Species of
Chironomidae (Diptera).
Can. Entomol., 110, 289-300 (1978)

Newly hatched larvae of CHIRONOMUS DECORUS, ENDOCHIRONOMUS NIGRICANS, and CHIRONOMUS STAEGERI mostly from a single shallow eutrophic pond near St. Catharines, Ont., were reared to the adult stage of 15 C and 20 C and 16 and 8 h daily photoperiods. Normal development to EM(50) took 26 days at 20 C and 37 days at 15 C in C. DECORUS; 35 and 48 days in E. NIGRICANS; and 68 days at 20 C in C. STAEGERI. The 8 h daily photoperiod inhibited emergence, by preventing pupation of final instar larvae, in E. NIGRICANS and C. STAEGERI at both temperatures, and in C. DECORUS at 15 C. Nevertheless, a few individuals emerged even under these conditions; such individuals may be important in insuring field populations against environmental variation. When any food-induced emergence had been completed, transfers to higher temperatures or longer photoperiods were made. Transfer after initial inhibition to regimes that normally permitted emergence resulted in emergence; and in E. NIGRICANS transfer at 8 h photoperiod from 15 C to 20 C also resulted in emergence, suggesting that the cues for induction and termination of dormancy are not the same, since 8 h photoperiod normally induces dormancy at both temperatures. Emergence after such transfer was more highly synchronized than in the initial period, but protandry was generally retained. (Auth)(MU)

<98>
Davis, W.L., and T.M. Freeze, Murray State University, Department of Biological Sciences, Murray, KY

The Occurrence and Relative Abundance of Planktonic Fish Larvae in Anderson Creek Embayment, Kentucky Lake, Kentucky.
Trans. Ky. Acad. Sci., 38, 120-122 (1977)

Larval fishes were collected from Anderson Creek embayment of Kentucky Lake with a 0.8-mm mesh plankton net and habitat seine to document the species of fishes utilizing the area as a spawning ground. The Clupeidae constituted 99.6% of the total catch while other species made up the remaining 0.4%. As the water temperature rose above 19.0 C, a sharp increase occurred in the total number of Clupeidae. The nonclupeid fishes were represented by MORONE sp. (above 17.0 C) and by POMOXIS sp. (between 19.0 and 22.0 C). (Auth)

<99>
Dawes, C.J., R.E. Moon, and M.A. Davis, University of South Florida, Department of Biology, Tampa, FL

The Photosynthetic and Respiratory Rates and Tolerances of Benthic Algae from a Mangrove and Salt Marsh Estuary: A Comparative Study.
Estuarine Coastal Marine Sci., 6, 175-185 (1978)

The study examines the net photosynthetic and respiratory rates of four dominant species of red algae from a salt marsh and three red and one green algae from a mangrove community with respect to light, temperature, salinity, and periods of desiccation. One intertidal species and one subtidal species were common to both sites. The highest rates of net photosynthesis for all species, measured over the range 12 to 42 C, occurred at 30 and 36 C. With one exception, the algae from the mangrove community showed significantly higher levels of photosynthesis under varying temperatures when compared with algae from the salt marsh community. The physiological tolerances of the algae to site and location along the west coast of Florida are discussed. The species studied were BOSTRYCHIA BINDERI, GRACILARIA VERRUCOSA, CLADOPHORA REPENS, ACANTHOPHORA SPICIFERA, CATENELLA REPENS and SPYRIDIA FILAMENTOSA. (ST)

<100>
de March, B.G.E., Fisheries and Marine Service, Department of Fisheries and the Environment, Freshwater Institute, Winnipeg, Manitoba, Canada

The Effects of Constant and Variable Temperatures on the Size, Growth, and Reproduction of Freshwater Amphipod HYALELLA AZTECA (Saussure).
Can. Jour. Zool., 56, 1801-1806 (1978)

In a study done on one laboratory population of HYALELLA AZTECA, the size at maturity of both males and females was determined to be dependent on temperatures during development. Temperatures of 10 and 15 C produced relatively large animals and also delayed reproductive development. Temperatures of 20 to 23 C produced relatively small animals, while 18 C produced animals of intermediate size. The temperatures to which the ovum and embryo were exposed were most strongly related to maturation sizes. The time to reach maturity and the embryonic development time were inversely correlated with temperature in animals reared at constant temperatures. The maturation times were longer than expected if early development occurred at lower temperatures, and shorter if early development occurred at higher temperatures. These laboratory results are discussed with respect to the natural size variation and its adaptive advantage in H. AZTECA and other related taxa. (Auth)

<101>
de Vlaming, V.L., Marquette University, Department of Biology, Milwaukee, WI

Effects of Photoperiod and Temperature on Gonadal Activity in the Cyprinid Teleost, NOTEMIGONUS CRYSOLEUCAS.
Biol. Bull., 148, 402-415 (1975)

The effects of various photoperiod-temperature regimes (15.5L/8.5D or 9L/15D, 12 or 25 C) on gonadal activity in the cyprinid teleost, NOTEMIGONUS CRYSOLEUCAS, were examined during several different phases of the annual reproductive cycle. Regardless of the time of year when the experiment was initiated, a long photoperiod-warm temperature regime stimulated gonadal development to the prespawning condition or induced spawning. Neither a warm temperature alone nor a long photoperiod alone stimulated final gonadal maturation. NOTEMIGONUS was not refractory to long photoperiod-warm temperature gonadal activation during the postspawning season. Short photoperiods in combination with warm temperatures caused gonadal regression in this species. A low temperature-short photoperiod regime did not induce gonadal involution. Spermatocyte formation and proliferation as well as the early phases of vitellogenesis occurred independently of environmental factors. Final gonadal maturation and the rate of gametogenesis, however, depend on specific environmental conditions. (Auth)

<102>
Deacutis, C.F., U.S. Environmental Protection Agency, Environmental Research Laboratory Narragansett, RI

Effect of Thermal Shock on Predator Avoidance by Larvae of Two Fish Species.
Trans. Amer. Fish. Soc., 107, 632-635 (1978)

Larvae of two fish species, MENIDIA MENIDIA and PARALICHTHYS DENTATUS, were subjected to a 15-min thermal shock of 10 C above acclimation temperature, returned to acclimation temperature, and exposed to a predator. FUNDULUS MAJALIS. Four- and six-week-old M. MENIDIA were significantly more vulnerable to predation after being shocked than control larvae, but younger larvae were not. Shocked larvae of P. DENTATUS were less susceptible to predation than control larvae. (Auth)

<103>
DeAngelis, D.L., Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN

A Model for the Movement and Distribution of Fish in a Body of Water.
ORNL/TM-6310, Oak Ridge National Laboratory, 61 pp. (1978)

The model was designed to simulate the movement of individual fish in a body of water and to predict the spatial patterns of a population of fish under the influence of temperature, dissolved oxygen levels, food availability, and habitat preferences. In trial simulations in which only temperature influenced movements, simulated fish were allowed to distribute themselves in a hypothetical body of water. The resultant distributions were compared with

<103>
<103> CONT.
experimental data on temperature preference. (ST)

<104>
Dentry, W., and C.C. Lindsey, University of Manitoba, Department of Zoology, Winnipeg, Manitoba, Canada

Vertebral Variation in Zebrafish (BRACHYDANIO RERIO) Related to the Prefertilization Temperature History of Their Parents.
Can. Jour. Zool., 56, 280-283 (1978)

Four breeding pairs of zebrafish were maintained at a low temperature (21, 22, or 24 C), and their eggs placed immediately after laying at one of a variety of temperatures (ranging between 21 and 33 C), in which they were reared until vertebral count was determined. The same breeding pairs were at another time maintained at a high temperature (29 or 30 C), and eggs were similarly placed for rearing at one of a variety of temperatures. Vertebral counts were compared between sets of samples reared at the same temperature and originating from the same parents but laid during periods with different parental holding temperatures. In the three cases where differences between such pairs were statistically significant, vertebral counts were higher in the sample originating from the higher parental holding temperature. If meristic characters are in fact partly dependent on temperature history of the parents before fertilization, many published experimental and racial studies may need to be reinterpreted. (Auth)

<105>
Dojlido, J.R., Institute of Meteorology and Water Economics, Department of Biology and Water Chemistry, Warsaw, Poland

Effect of Heated Waters on Biocenosis of the Moderately Polluted Narew River. Physico-Chemical Conditions.
Pol. Arch. Hydrobiol., 23, 487-498 (1976)

The effect of heated water discharge from the Ostroleka power plant (680 MW) on the quality of water in the moderately polluted Narew River (Poland) was investigated. Up to 40% of the river water flow was utilized for the cooling system. The increase in temperature of the river water (1.5 km downstream of the power plant) ranged up to 2 C. Maximum temperature of the river water was 28.5 C. The heated waters did not cause any negative changes in the quality of the water. Only slight decreases in the concentration of dissolved oxygen and BOD and slight increases in the concentration of nitrites were observed. (Auth)(MU)

<106>
Domanik, A.M., and J.H. Zar, Northern Illinois University, Department of Biological Sciences, DeKalb, IL

The Effect of Malathion on the Temperature Selection Response of the Common Shiner, NOTROPIS CORNUTUS (Mitchill).
Arch. Environ. Contam. Toxicol., 7, 193-206 (1978)

Warm-(17 C) and cold-acclimated (8 C) young-of-the-year, 1-year old, and 2-year-old common shiners, NOTROPIS CORNUTUS (Mitchill) were exposed for 24 hr to sublethal doses (1.0, 0.25, and 0.05 ug/l) of malathion to determine the effect of environmental concentrations of this compound on temperature selection. All three factors studied (acclimation temperature, age, and concentration) were found to affect the temperature selection response of malathion-treated fish. Malathion produced dose-dependent decreases in selected temperature (1.9 to 4.3 C below controls) in 17 C-acclimated fish but not in 8 C-acclimated fish. Two-year-olds treated with 1.0 ug/l displayed the greatest lowering of selected temperature, followed by two-year-olds treated with 0.25 ug/l. One-year-olds treated with 1.0 ug/l showed a slight lowering, while no downward shifts in selected temperature were found for young-of-the-year. Exposure to 0.05 ug/l had no effect on any age group.
Two-year-olds acclimated to 17 C and exposed to 1.0 ug/l malathion for 24 hr were placed in clean water and allowed to recover from the pesticide. It was found that the lowered selected temperature induced by malathion returned to that of the controls in 24 hr. (Auth)

<107>
Donovan, O., D. Doyle, C. O'Neill, and E. Kearns, Jersey City State College, Jersey City, NJ

Oyster Creek I: Thermal Plume Impact on Fish Distributions in Barnegat Bay.
Underwater Naturalist, 10, 14-18 (1977)

Fish sampling at stations near the intake and discharge canals of the Oyster Creek nuclear power station on Barnegat Bay, NJ, documented avoidance of the thermal plume by a number of important finfish. In terms of total numbers, summer flounder, tautog, bluefish, lookdowns, and pipefish appeared to be avoiding the thermal effluent. Toadfish and blowfish were found in greater total numbers within the plume. Silversides and blue crabs also exhibited avoidance, but much less markedly than the first five species. The presence of blue crabs and toadfish and blowfish which feed heavily on crabs might indicate a shift towards the scavenger level of the food chain. Levels of organic debris in the discharge are probably higher than in the intake due to entrainment kill and the dumping of impinged organisms in the discharge canal. Sampling of smaller fish and crustaceans during the colder months of the year indicated a marked attraction to the heated effluent. The plume at times extends across the entire width of Barnegat Bay, a distance of almost four miles. (ST)

<108>
Dregolskaya, J.N., Institute of Cytology, Leningrad, USSR

Heritability Coefficient of Heat Resistance in HYDRA OLIGACTIS Pall. at the Optimal Temperature of Cultivation and during Heat Acclimation.
Zhur. Olish. Biol. (USSR), 38, 440-446 (1977)

Heritability of heat resistance of HYDRA OLIGACTIS was studied at optimum temperatures for this species (21 to 22 C) and following acclimation to 27.5 C. The survival time logarithm at 35 C was used as a criterion of heat resistance. At the optimum temperature, inheritance of heat resistance was high. During acclimation to higher temperatures there was a decrease in the heritability coefficient (the masking of genetic differences between clones), which resulted in poor selective elimination of individuals and thus preservation of genetic diversity. (ST)

<109>
Duangsawasdi, M., University of Manitoba, Canada

Organophosphate Insecticide Toxicity in Rainbow Trout (SALMO GAIRDNERI). Effects of Temperature and Investigations on the Sites

<109> CONT.
of Action.
Ph.D. Thesis, University of Manitoba (1977)

The organophosphorus insecticides, acephate and fenitrothion were tested on rainbow trout fingerlings to study the effects of temperature stress on acute lethality and cholinesterase inhibition in brain and skeletal muscle. Temperature stress affected the acute lethality of each insecticide but was more pronounced with fenitrothion than with acephate during the first 24 hour period. The effects of temperature stress became less after 48 hours and no significant effects were observed after 96 hours of exposure. Expressed as LC50 values, the toxicity of fenitrothion was about 600 to 1000 times greater than acephate depending upon test temperature. (ST)

<110>
Dumont, P., and R. Fortin, University of Quebec at Montreal, Biological Sciences, Montreal, Quebec, Canada

Aspects of the Biology of the Lake Whitefish CORMEGONUS CLUPEAFORMIS from Lake Helene and Lake Nathalie, James Bay Area.
Can. Jour. Zool., 56, 1402-1411 (1978)

The life history of lake whitefish in lakes Nathalie and Helene was studied between June 1974 and November 1975. The age of 840 specimens was determined from the scales. Growth rates were very slow, compared only with those of dwarf whitefish of certain North American lakes. Food varied with the length of the fish and with the season of the year. Main food items were aquatic insects (larvae and adults), mollusks, and small fishes. In 1975, spawning occurred in late October (water temperature: 4 C), at depths of 2 to 4 m; substrates utilized were sand, gravel, and boulders. Spawning lasted less than two weeks. Males matured at 390 mm(age 8) and females at 400 mm(age 9). Lake Nathalie whitefish showed a low relative fecundity. In the fall of 1974, the population density of Lake Nathalie whitefish 350 mm and longer was estimated at 839 individuals. (Auth) (MU)

<111>
Durbin, E.G., University of Rhode Island, Graduate School of Oceanography, Kingston, RI

Aspects of the Biology of Resting Spores of THALASSIOSIRA NORDENSKIOELDII and DETONULA CONFERVACEA.
Marine Biol. (W. Ger.), 45, 31-37 (1978)

Large numbers of resting spores of THALASSIOSIRA NORDENSKIOELDII and DETONULA CONFERVACEA were produced when these species were grown at low levels of ammonia and nitrate. The production of resting spores by T. NORDENSKIOELDII was inversely related to temperature. At 0 and 5 C between 68 and 96% of the total cells were resting spores, while at 15 C resting spores were not produced. Resting spores of both species would not survive seven days in the dark at 20 C. At 0, 5, 10, and 15 C, the length of time that the resting spores of both T. NORDENSKIOELDII and D. CONFERVACEA remained viable was 576 days. The data suggest that the production of resting spores by these two species does not aid them in the survival of unfavorably high temperatures such as are found in temperate estuaries during the summer. Rather, they appear to be an adaptation for the survival of long periods of darkness in polar regions. (Auth)

<112>
Dusoge, K., and R.J. Wisniewski, Polish Academy of Sciences, Department of Hydrobiology, Institute of Ecology, Lomianki, Poland

Effect of Heated Waters on Biocenosis of the Moderately Polluted Narew River. Macrobenthos.
Pol. Arch. Hydrobiol., 23, 539-554 (1976)

The effect of the discharge of heated waters from a power station on the species composition, dynamics of growth, and density of benthos was studied in the lowland Narew River (Poland). The investigations comprised a 113-km-long sector of the river starting in the region of the power station at Ostroleka down to the Zegrzynski Dam Reservoir. The discharge of heated water from the power station caused a slight rise of water temperature in the river not higher than 2 C above the normal temperature in the summer. The rise of water temperature brought about some changes in the benthos structure, not observed beyond the range of the heated zone, i.e., a decrease in the number of species (especially Chironomidae larvae), and increase of predatory forms in the total number of benthic organisms, and fluctuations in the density of benthic populations, which was interpreted as a decrease in the stability of benthic communities. The range of these changes was particularly wide in those sectors of the river where the effects of increased temperature were combined with the effects of pollution from sewage and industrial effluents. (Auth) (MU)

<113>
Edwards, D.C., and J.D. Huebner, University of Massachusetts, Department of Zoology, Amherst, MA

Feeding and Growth Rates of POLINICES DUPLICATUS Preying on MYA ARENARIA at Barnstable Harbor, Massachusetts.
Ecology, 58, 1218-1236 (1977)

The year-round feeding and growth rates and patterns of prey utilization of the marine snail POLINICES DUPLICATUS consuming the clam MYA ARENARIA were monitored under field conditions. The major factors affecting feeding rates were food supply, temperature, predator size or weight, and recent feeding experience. Provided with excess prey of differing sizes, POLINICES of each size or age ate a mean number of 95.5 MYA per year. Feeding varied directly with temperature, peaking at 0.6 MYA per snail per day in the warm months, but ceasing at 5 C for four months in winter. (ST)

<114>
Ehrlich, K.F., Occidental College, Biology Department, Los Angeles, CA

Inhibited Hatching Success of Marine Fish Eggs by Power Plant Effluents.
Marine Poll. Bull., 8, 228-229 (1977)

Embryos of the California grunion (LEURESTHES TENUIS) were maintained under static conditions at 18, 22 or 24 C in water taken from the intake and discharge of a power plant cooling system. The water in the incubation tanks was replaced daily. The hatching success of the grunion eggs was 65.8 to 85.7% in the effluent water and 89.8 to 93.4% in the intake water. The observed differences were statistically significant. The lower rate of hatching could not be correlated with morphological abnormalities in the embryos. (DHO)

<115>
<115>
Eidman, M., Texas A&M University, College Station, TX

Species Composition, Abundance and Distribution of Macro-Crustaceans and Fishes in the Intake Area, Discharge Canal, and Cooling Lake of the Cedar Bayou Electric Generating Station, near Baytown, Texas.
Ph.D. Thesis, Texas A&M University, 349 pp. (1978)

Species composition, abundance, and distribution of macrocrustaceans and fishes in the intake area, discharge canal and cooling lake of the Cedar Bayou electric generating station near Baytown, Texas, were analyzed using data collected by trawling, trammelling, and seining from November 1973 through September 1975. Reversed water flow in Cedar Bayou improved water quality in the area and led to an increase in the number of species caught in the intake area. In general, the mean catch per unit of effort of migratory species increased soon after the plant began operation but eventually leveled off. The mean catch per unit effort of resident species decreased soon after start-up but later increased again. The decline of ARIUS FELIS and MUGIL CEPHALUS populations appeared to be caused by limited recruitment. Temperature and its interaction with other variables were the most important variables in determining abundance of organisms. Number of species and their abundance increased in the study area as a result of power plant operation. In subsequent years population changes were less apparent and they showed more independence of the power plant operation. (ST)

<116>
El-Hawawi, A.S.N., and P.E. King, University College of Swansea, Department of Zoology, Swansea, Wales

Salinity and Temperature Tolerance by NYMPHON GRACILE (Leach) and ACHELIA ECHINATA (Hodge) (Pycnogonida).
Jour. Exp. Mar. Biol. Ecol. (Neth.), 33, 213-221 (1978)

The tolerance of two species of sea spiders to a range of salinities, temperatures, and relative humidities was examined. At 15 C, survival increased with increasing salinities above 17 ppt. Experiments at higher temperatures showed that ACHELIA ECHINATA is more tolerant than NYMPHON GRACILE. At a salinity of 34 ppt N. GRACILE was active up to 28 C. At 30 C animals entered a heat coma. Corresponding values for A. ECHINATA were 30 and 32 C. The tolerance of A. ECHINATA to high temperatures varied with season, but there was no seasonal difference in the reaction to lower temperatures. High temperature tolerance of the two species was correlated with distribution in the littoral zone. (ST)

<117>
Elliott, J.M., Freshwater Biological Association, Windermere Laboratory, England

Effect of Temperature on the Hatching Time of Eggs of EPHEMERELLA IGNITA (Poda) (Ephemeroptera: Ephemerellidae).
Freshwater Biol., 8, 51 (1978)

Eggs of EPHEMERELLA IGNITA were kept at eight constant temperatures (5.9 to 19.8 C) in the laboratory. Over 85% of the eggs hatched in the temperature range 10.0 to 14.2 C, but the percentage decreased markedly to 39% at 5.9 C and 42% at 19.8 C. Hatching time decreased with increasing water temperature over the range 5.9 to 14.2 C and the relationship between the two variables was well described by a hyperbola. The time taken for development was expressed in units of degree-days above a threshold temperature. Mean values were 552 degree-days above 4.25 C for 10% of the eggs hatched, 862 degree-days above 3.57 C for 50% hatched, and 1383 degree-days above 3.14 C for 90% hatched. These values can be used to predict hatching times at temperatures below 14.68 C for 10% hatched, 14.54 C for 50% hatched and 14.45 C for 90% hatched. At higher temperatures, the hatching time and the number of degree-days required for development both increased with increasing temperature. Equations were developed to estimate the number of degree-days required for development at these higher temperatures. There was good agreement between estimates of hatching times of eggs placed in a small stream and the actual hatching times. (Auth) (ST)

<118>
Enright, J.T., University of California, Scripps Institution of Oceanography, LaJolla, CA

Power Plants and Plankton.
Marine Poll. Bull. (G.B.), 8, 158-161 (1977)

The use of coastal oceanic waters in the cooling systems of power plants leads to the destruction of large numbers of planktonic larvae of nearshore fish and invertebrates. As a first-order approach toward assessing the maximum probable impact of such larval mortality upon the adult populations, one can assume that recruitment to local populations is due to larvae from distant sources, which have a recruitment success independent of adult density; and that adult mortality is density-independent. These worst-possible-case assumptions lead to the interpretation that impact on adult populations could be adequately evaluated by measuring-or predicting-the power plant imposed reductions in larval density in those nearshore waters from which recruitment occurs. (Auth)

<119>
Eriksson, S., and A.M. Edlund, Uppsala University, Institute of Zoology, Uppsala, Sweden

On the Ecological Energetics of O-Group CARCINUS MAENAS (L.) from a Shallow Sandy Bottom in Gullmar Fjord, Sweden.
Jour. Exp. Mar. Biol. Ecol. (Neth.), 30, 233-248 (1977)

Shore crabs, CARCINUS MAENAS, younger than one year, were investigated from June 1975 to September 1976 on a shallow sandy bottom at Kvarnbukten Bay, Gullmar Fjord on the Swedish west coast. The salinity varied around 25 ppt and the monthly mean temperature ranged from 0.7 to 17.6 C. Growth (production of living tissue and production of eliminated carapaces) occurred only at temperatures higher than 10 C, i.e., August to October and May to July. During August and September the individuals moulted 4 times and during May to July, 3 times. Sexual maturity was reached after 2 years. The relationship between temperature and log oxygen consumption was linear between 0 and 30 C. (MU)

<120>
Evans, D.O., University of Toronto, Toronto, Canada

Seasonal Changes in Standard Metabolism, Upper and Lower Thermal Tolerance and Thermoregulatory Behaviour of the Pumpkinseed, LEPOMIS GIBBOSUS (Linnaeus).
Ph.D. Thesis, University of Toronto (1977)

<120> CONT.

Routine and standard metabolic rate of the pumpkinseed, LEPOMIS GIBBOSUS, was shown to increase by 60 to 80% from winter (Jan.-March) minima to spring (April-June) maxima independently of acclimation temperature over the range tested (8 to 32 C). Upper thermal tolerance changed seasonally independent of acclimation temperature (4 to 34 C) but lower thermal tolerance did not. Upper thermal tolerance was greater during summer than during winter but only at acclimation temperatures above 20 C. The ultimate upper incipient lethal temperatures during winter and summer were 33.0 and 38.5 C respectively. At extreme low and high temperatures young-of-the-year pumpkinseed were found to be less resistant than larger adult pumpkinseed. Near the incipient lethal level, resistance of young-of-the-year and adult pumpkinseed was similar. Disruption of the normal photocycle caused resistance to high temperature to remain near the winter resistance level. The final preferendum of similarly acclimated (20 C) adult pumpkinseed tested in a fish-controlled apparatus was lower in winter (28.5 C) than during spring and summer (31.7 C). The final preferendum of adult fish tested in spatial gradients ranged seasonally from 26.5 C during late fall to 32.5 C during late spring. Juveniles tested during the fall had a preferendum approximately 2 C higher than adults. (MU)

<121>

Evans, F., and W. Diaz, University of Newcastle on Tyne, Dove Marine Laboratory, England; Universidad Del Zulia, Departmento de Biologica, Maracaibo, Venezuela

MICROSETELLA NORVEGICA (Boeck): A Direct Relationship between Seasonal Sea Temperature and Adult Size in a Planktonic Copepod.
Crustaceana, 34, 313-315 (1978)

The planktonic harpacticoid, MICROSETELLA NORVEGICA was larger in the summer than in the spring and its size was directly related to sea temperature. This is contrary to the usual inverse relationship between water temperature and planktonic copepod size. (ST)

<122>

Everest, G., University of Toronto, Department of Zoology, Toronto, Ontario, Canada

Some Effects of Heated Effluents on Fish Populations at Three Thermal Generating Stations.
M.S. Thesis, University of Toronto, Ontario, Canada, 151 pp. (1973)

The relative distribution of fish between the heated effluents and the adjacent receiving waters was compared at the Richard L. Hearn and the Lakeview fossil-fueled stations on Lake Ontario and the Douglas Point nuclear station on Lake Huron. Most species of fish were attracted to the effluents during the cooler months of the year (with the exception of winter) but as effluent temperatures rose above their final preferenda in summer they left the effluents for cooler water. The temperatures selected agreed well with laboratory final preferenda except for alewives and splake which showed a preference for near-lethal temperatures. The effluents did not appear to impede or alter normal seasonal migrations. Most species left inshore waters in winter so there was no danger of cold death due to winter shut-down. The annual die-off of alewives in spring and early summer may be increased by the warm temperatures of the Hearn and Lakeview effluents. Fungus infection of gizzard shad was higher in the Lakeview effluent; lamprey predation was higher on gizzard shad at Lakeview and higher on longnose suckers at Douglas Point. For other species there was no difference in levels of disease and parasitism between effluent and control catches. There also appeared to be no differences in gonad development, quantity or type of food, or length-weight relationship. (MU)

<123>

Ezzat, A., and S. El-Serafy, Alexandria University, Oceanography Department, Faculty of Science, Egypt

The Migration of Elvers of ANGUILLA ANGUILLA L. in the Mex Canal, Alexandria, Egypt.
Jour. Fish Biol., 11, 249-256 (1977)

The run of elvers of ANGUILLA ANGUILLA (L) up the Mex canal, Alexandria, Egypt, started at the end of February and continued until June, with the main bulk of elvers arriving in April and May. Variations in the timing of this run were attributable to variations in local ecological conditions. The run was affected by meteorological and hydrographic factors. The effects of the latter have been assessed, and a low oxygen content, a pH between 7.7 and 8.0, a chloride content between 2.1 and 2.3 Cl/l and a temperature between 20 and 25 C have been found to encourage large numbers of elvers to migrate up the fresh water canal. In contrast to previous findings, the results of this study suggest that the mean length of elvers running increases towards the end of the season. (Auth)

<124>

Fales, R.R., Rutgers University, Department of Zoology, New Brunswick, NJ

The Influence of Temperature and Salinity on the Toxicity of Hexavalent Chromium to the Grass Shrimp PALAEMONETES PUGIO (Holthuis).
Bull. Environ. Contam. Toxicol., 20, 447-450 (1978)

The influence of hexavalent chromium (potassium chromate) to the grass shrimp PALAEMONETES PUGIO was studied using static 48-h acute toxicity bioassays performed at eight different temperature-salinity combinations (10, 15, 20, and 25 C x 10 and 20 ppt). The capacity of hexavalent chromium to cause physiological damage to PALAEMONETES PUGIO was enhanced by increased temperature or decreased salinity as evidenced by smaller TLm values. The susceptibility of the shrimp was greatest at 25 C and 10 ppt and least at 10 C and 20 ppt. The effects of both variables were pronounced, but salinity was more consistent in altering toxicity. (ST)

<125>

Feinstein, R., H. Pinsker, M. Schmale, and B.A. Gooden, University of Texas Medical Branch, Marine Biomedical Institute, Galveston, TX

Bradycardial Response in APLYSIA exposed to Air.
Jour. Comp. Physiol, 122, 311-324 (1977)

Heart rate was chronically monitored in two species of the marine gastropod APLYSIA. The warm water A. BRASILIANA had an average basal heart rate in water of 33/min, whereas the cold water A. CALIFORNICA's heart rate was 20.6/min. The heart rate in both species showed a strong temperature dependence and the difference in basal heart rate was negligible when measured at the same temperature. Both species showed a consistent bradycardia when exposed to air.

<125>
<125> CONT.
(Auth) (ST)

<126>
Feldmeth, C.R., and J.N. Baskin, Claremont Colleges, Joint Science Department, Claremont, CA; California State Polytechnic University, Department of Biological Sciences, Pomona, CA

Thermal and Respiratory Studies with Reference to Temperature and Oxygen Tolerance for the Unarmored Stickleback GASTEROSTEUS ACULEATUS WILLIAMSONI Hubbs.
Southern Calif. Acad. Sci., 75, 127-131 (1976)

The tolerance to high temperature and low oxygen concentration was measured for the unarmored stickleback. These fish have a critical thermal maximum (CTM) of 30.5 C when acclimated to 8 C and a CTM of 34.6 C when acclimated to 22.7 C. Respiratory experiments indicated that the critical oxygen concentration for this species is about 2.0 ppm. Above this concentration, the respiratory rate is independent of oxygen concentration; however below 2.0 ppm, oxygen consumption rapidly declines. To maintain respiratory independence as oxygen concentration decreases, ventilatory rate rises rapidly. In an oxygen concentration of 7.4 ppm the mean ventilatory rate is 104.6/min. As the oxygen decreases, ventilatory rate increases to 230.7/min in 1.32 ppm of oxygen. In lower oxygen concentrations, gill ventilation rapidly decreases. (Auth)

<127>
Feldmeth, C.R., E.A. Stone, and J.H. Brown, Claremont Colleges, Joint Science Department; Claremont, CA; University of Utah, Department of Biology, Salt Lake City, UT

An Increased Scope for Thermal Tolerance upon Acclimating Pupfish (CYPRINODON) to Cycling Temperatures.
Jour. Comp. Physiol. 89, 39-44 (1974)

Pupfish (CYPRINODON NEVADENSIS AMARGOSAE), which inhabit shallow, thermally instable desert waters were acclimated to a series of constant temperatures (15, 25, and 33 C) and to a symmetrical fluctuating temperature regime (15-35 C). A range or scope of thermal tolerance of 39 C between critical thermal maxima and minima exists for this species. Upon acclimation to cycling temperatures, this tolerance range increased significantly to amost 41 C. Hence, these fish can apparently compensate physiologically for both warm and cold temperatures simultaneously. (Auth)

<128>
Feller, R.J., University of Washington, Seattle, WA

Life History and Production of Meiobenthic Harpacticoid Copepods in Puget Sound.
Ph.D. Thesis, University of Washington, 262 pp. (1977)

The life history, distribution, abundance, and carbon production of meiobenthic harpacticoid copepods were studied on three similar sand beaches in Puget Sound. In the laboratory, cultures fed with excess benthic diatoms provided estimates of development rates, hatching success, and mortality. HUNTEMANNIA JADENSIS reached maturity in 95 days at 8 C, 66 days at 12 C, and 50 days at 15 and 20 C. Generation time was 167 days at 8 C. Egg mortality per brood ranged from 17 to 83% and naupliar mortality ranged from about 3 % at 8 and 12 C to 100% at 4 C. Copepodites suffered less than 25% mortality per stage. Females lived for more than one year and some produced four broods in culture. (ST)

<129>
Ferguson, V.M., and R.C. Fox, Clemson University, Department of Entomology and Economic Zoology, Clemson, SC

A Comparison of Aquatic Insects in Natural Inlets with Those in the Heated Effluent from the Oconee Nuclear Station - Littoral Zone.
Jour. Georgia Entomol. Soc., 13, 202-213 (1978)

Aquatic insects in natural inlets were compared with those in the heated effluent from the Oconee Nuclear Station on Lake Keowee, S.C. Comparisons showed the discharge cove to be the least productive, but more diverse in chironomid genera than at least one of the control inlets. Type of substrate, organic matter, and water level had a direct effect on the abundance of insects. The thermal effluent was the probable cause of the elimination of four insect orders (Ephemeroptera, Hemiptera, Odonata, and Trichoptera) in the discharge cove. The thermal effluent was also the probable cause of shifts in the time of peak insect populations. (ST)

<130>
Fey, J.M., Ruhr-Universitat Bochum, Institut Spezielle Zoologie, Germany

The Heating of a Mountain Stream and the Effects on the Zoocoenosis Demonstrated on the Lenne (Sauerland).
Arch. Hydrobiol. Suppl. (Ger.), 53, 307-363 (1977)

From 1973 to 1975 effects of cooling water from the Elverlingsen Power Station (West Germany) on the biota of the Lenne River were observed. Field studies involved observations on the abundance, dominance, drift activity, and larval development of the most important benthic organisms. Particular attention was paid to HYDROPSYCHE PELLUCIDULA, which hatches up to four months earlier in the thermally-affected area below the power plant than above it. Abundance of HYDROPSYCHE was lower at the outfall compared to other stations. The second part of the study involved temperature studies, including thermal shock studies, with HYDROPSYCHE, EPEORUS, and DINOCRAS larvae. (ST)

<131>
Fey, J.M., and H. Schuhmacher, Ruhr University, Department of Biology, Germany

On the Impact of Changing Temperatures on the Net Spinning by Larvae of the Caddisfly Species HYDROPSYCHE PELLUCIDULA (Trichoptera: Hydropsychidae).
Entomol. Ger., 4, 001-011 (1978)

Net spinning activity of HYDROPSYCHE PELLUCIDULA increased with increasing temperature up to 15 C; at higher temperatures activity decreased. Oscillating temperatures resulted in decreased activity and in alterations in net structure, affecting its catching capacity. Mesh size appeared to be determined by the temperature-dependent speed of net production. (ST)

<132>
Fiala-Medioni, A., Universite Paris VI, Laboratoire Arago, Banyuls-sur-Mer, France

Filter-Feeding Ethology of Benthic Invertebrates (Ascidians). V. Influence of Temperature on

<132> CONT.
Pumping, Filtration and Digestion Rates and Rhythms in PHALLUSIA MAMILLATA.
Marine Biol. (W. Ger.), 48, 251-259 (1978)

The influence of temperature on the pumping, filtration, and digestion rates of PHALLUSIA MAMMILLATA were studied over the range 7 to 25 C. Water pumping rate was highest at 15 C, ceased at 7 C and was irregular above 20 C. Filtration showed no rhythm, and like pumping rate was maximum at 15 C (4,286 ml/h-g dry wt), decreasing with lower and higher temperatures. The digestion rate was also maximum at 15 C, decreasing at 10 and 20 C. The higher temperature affected the percentage of food utilization, with smaller values at 20 C than at 10 and 15 C. (ST)

<133>
Fiore, J., Suffolk University, Department of Biology, Boston, MA

Life History and Taxonomy of STICTYOSIPHON SUBSIMPLEX Holden (Phaeophyta, Dictyospihonales) and FARLOWIELLA ONUSTA (Kutzing) Kornmann in Kuckuck (Phaeophyta, Ectocarpales).
Phycologia, 16, 302-311 (1977)

Field and laboratory-culture studies show that STICTYOSIPHON SUBSIMPLEX and FARLOWIELLA FONUSTA are the sporophytic and gametophytic generations, respectively, of a single heteromorphic species. Unilocular sporangia are produced by field and laboratory-grown plants only at temperatures of 20 C or higher, whereas plurilocular sporangia are produced at temperatures below 20 C. Chromosome counts of 22 plus in cortical cells and 13 in 4-nucleate unilocular sporangial initials of S. SUBSIMPLEX indicate meiosis occurs in unilocular sporangia. The morphology and development of spores, gametes and gametophyte of this endemic North American species differ too significantly from those of other STICTYOSIPHON spp. for it to be retained in that genus. Since the only other available generic name; FARLOWIELLA, is illegitimate, the generic name HUMMIA and the combination H. ONUSTA (Kutzing) Fiore have been proposed. (Auth)

<134>
Fjerdingstad, E., University Institute of Hygiene, Copenhagen, Denmark

Effect of Warm Water Discharges from Power Plants on the Bacterial Decomposition in the Bottom Mud of a Stream.
Arch. Hydrobiol. Beih. Ergebn. Limnol. (Ger.), 9, 223-237 (1977)

Bacteriological processes going on in the sediments of a watercourse receiving hot cooling water from a conventional type of power plant were investigated in Denmark. Water temperatures ranged from around 30 C in summer to just above 0 C in winter. Heterotrophic bacteria, autotrophic bacteria, and bacteria indicating fecal pollution were analyzed. Bacteriological sediment data (numbers of bacteria per gram of sediment) were compared with data from streams not receiving thermal effluents. No indication of any appreciable increase in the decomposition of organic matter was found. (NU)

<135>
Floyd, W.R., Old Dominion University, Institute of Oceanography, Norfolk, VA

The Effects of Temperature and Salinity on the Larval Development of the Grass Shrimp, PALAEMONETES PUGIO Reared in the Laboratory.
Vir. Jour. Sci., 28, 92 (Abstract only) (1977)

<132>

PALAEMONETES PUGIO larvae, obtained by induced breeding of adults from the Lafayette R., Norfolk, VA., were reared in the laboratory using a six temperature (10 to 32.5 C) by seven salinity (5 to 35 ppt) factorial design in order to determine the effects of these factors on their development. At each of the 42 T-S combinations, 36 zoeae were reared individually using 25 ml of artificial seawater with 25 ppm of polyethylene oxide added to reduce deaths due to standing. Food consisted of 30 ARTEMIA nauplii/ml of culture water. Results indicated that temperature, salinity, and their interaction have a highly significant effect on survival, larval duration, number of molts, and intermolt duration. Nearly 100% survival to metamorphosis can be expected at the optimum conditions of 20 to 30 C at 20 to 25 ppt. From 15 to 30 C, mean larval duration decreased with increasing temperature from 116.5 to 16.7 days. Individual zoeae had a range of from 11 days at 30 C - 35 ppt to 184 days at 15 C - 250 ppt. The mean number of molts to postlarva was lowest (8.1 and 8.3) at 20 and 25 C, with increases to 11.3 molts at 32.5 C and 13.4 molts at 15 C. Individual zoeae had a range of from six molts at 30 C-35 ppt to 20 molts at 15 C - 30 ppt. From 15 to 32.5 C the mean intermolt duration decreased with increasing temperature from 8.7 days to 1.7 days. Individual zoeae had a range of from 1.45 days at 32.5 C - 25 ppt to 10.2 days at 15 C - 25 ppt. (Auth)

<136>
Fowler, S.W., M. Heyraud, and J. La Rosa, Musee Oceanographique, International Laboratory of Marine Radioactivity, Principality of Monaco

Factors Affecting Methyl and Inorganic Mercury Dynamics in Mussels and Shrimp.
Marine Biol. (W. Ger.), 46, 267-276 (1978)

Radiotracer experiments were designed to study the effect of certain factors on the accumulation and loss of methyl and inorganic mercury in mussels (MYTILUS GALLOPROVINCIALIS) and benthic shrimp (LYSMATA SETICAUDATA). Methyl mercury was accumulated from both food and water to a greater degree than inorganic mercury by both species. There was a tendency for small mussels to concentrate more mercury than larger individuals. A trend towards greater mercury accumulation at higher temperatures was noted for mussels, but the temperature effect was relatively small over a 10 C range between 8 and 18 C. Methyl mercury residues were eliminated by both species more slowly than those of the inorganic form. Loss from mussels was somewhat more rapid at higher temperatures; however, as in the case of accumulation, the effect of temperature was relatively small. Enhanced methyl mercury elimination was noted for the group of mussels maintained in their natural environment. (Auth) (ST)

<137>
Fried, S.M., J.D. McCleave, and G.L. LaBar, University of Maine, Migratory Fish Research Institute and Department of Zoology, Orono, Maine

Seaward Migration of Hatchery-Reared Atlantic Salmon, SALMO SALAR, Smolts in the Penobscot River Estuary, Maine: Riverine Movements.
Jour. Fish. Res. Bd. Can., 35, 76-87 (1978)

Hatchery-reared Atlantic salmon tagged with ultrasonic transmitters were tracked in the Penobscot River estuary, Maine. Onset of increased activity of smolts occurred when

<137>
<137> CONT.
hatchery and river water temperature rose above 5 C. Full expression of migratory behavior occurred above 9 C. Earlier increased movement during one of the two years of study coincided with earlier warming trends. (ST)

<138>
Fritz, D.G., and F. Punzo, Blackburn College, Department of Biology, Carlinville, IL

Upper Lethal Temperatures and Effects of Acclimation in Naiads of the Dragonfly, PLATHEMIS LYDIA (Odonata: Libellulidae).
Trans. Ill. State Acad. Sci., 69, 292-301 (1976)

The effects of cold and warm acclimation on the upper lethal temperature of naiads of the dragonfly, PLATHEMIS LYDIA, were investigated. The upper lethal temperatures of naiads acclimated to 5, 20, and 36 C were 41.7, 42.7, and 43.2 C, respectively. (ST)

<139>
Fruh, E.G., B. Maguire, Jr., and P.S. Schmidt, Center for Research in Water Resources, University of Texas, Austin, TX

Before and After Studies on the Effects of a Power Plant Installation on Lake Lyndon B. Johnson: After Studies.
Technical Report EHE-77-04, CRWR-151 (1977)

Pre- and postoperational studies on the effects of the Thomas C. Ferguson generating station on Lake Lyndon B. Johnson are reported. There was no significant effect due to power plant operation on the temperature, water quality, phytoplankton, zooplankton, benthic organisms and fish of the lake. Following lowering and refilling of the lake in 1971, the percent of rough fish has stabilized and remains high. Sampling locations and frequency are discussed. Each fish species in the lake is briefly described. (ST)

<140>
Furnas, M., University of Rhode Island, Graduate School of Oceanography, Kingston, RI

Influence of Temperature and Cell Size on the Division Rate and Chemical Content of the Diatom CHAETOCEROS CURVISETUM Cleve.
Jour. Exp. Mar. Biol. Ecol. (Neth.), 34, 97-109 (1978)

Cell size and temperature influenced the division rate and chemical content of the diatom CHAETOCEROS CURVISETUM Cleve when grown at 15, 20 and 25 C in nutrient replete media. Cell-size dependent trends of division rate in individual clones changed with temperature in a complex fashion. Considerable interclonal variability in division rate within a restricted range of cell sizes was also found. Growth was marginal at 30 C and not observed at 10 C. Clones cultured at 15 C divided significantly faster than those cultured at 20 C. The division rates of large clones at 20 and 25 C did not differ significantly. For reasons unknown, 20 C clones less than 6 um divided significantly slower than 15 C clones in this size range. Cellular levels of carbon, nitrogen, protein, chlorophyll a, and silicon were linearly related to cell size. Cellular levels of carbon and chlorophyll per unit volume and silicon per unit surface area changed with temperature. No temperature effect on cellular levels of nitrogen and protein was found. (Auth)(NU)

<141>
Gable, M.F., and R.A. Croker, University of New Hampshire, Department of Zoology and Jackson Esturaine Laboratory, Durham, NH

The Salt Marsh Amphipod, GAMMARUS PALUSTRIS Bousfield, 1969 at the Northern Limit of its Distribution. II. Temperature-Salinity Tolerances.
Estuarine Coastal Mar. Sci., 6, 225-230 (1978)

The tolerance of GAMMARUS PALUSTRIS to temperature-salinity combinations was examined, with emphasis on low temperatures and salinities of late winter and early spring. The species is quite eurythermal and euryhaline. Differences in tolerances were related to life stage and seasonal acclimation of two generations. Juveniles tolerated low salinities better than adults, and appeared to be living closest to their upper lethal temperature limit compared with other life stages. Immature, over-wintering animals showed best tolerance to low temperatures and salinities of late winter and early spring, assisted by relatively high blood osmoconcentrations. It is concluded that G. PALUSTRIS may be living near its low lethal temperature limits in New Hampshire. (Auth)

<142>
Gaudy, R., Centre Universitaire de Luminy, Station Marine d'Endoume et Laboratoire d'Hydrobiologie Marine, Marseille, France

Study on Respiratory Metabolism Modifications in ACARTIA CLAUSI (Crustacea: Copepoda) after Passage through the Cooling Circuit of a Power Plant.
Marine Biol. (W. Ger.), 39, 93-104; Tethys, 8, 93-104 (1977)

The respiratory metabolism of the copepod ACARTIA CLAUSI was studied at different temperatures during an annual cycle. Copepods were collected from three different stations: the intake area, where sea water was pumped into the cooling circuit of a power plant; the outlet area of this circuit, where the heated effluents were discharged with an average delta of 6 C; and a small protected bay directly influenced by the flow of the heated waters. Seasonal variations in respiration intensity were observed, with a spring maximum. Specimens collected from the heated effluents exhibited comparatively reduced metabolism. Q10 varied with temperature and time of year, suggesting seasonal regulation of metabolism. Except in March, where metabolic curves differed markedly according to the origin of the sample (species from the heated effluents displaying a metabolic curve of the summer type), the principal difference of shape of the respiration-temperature curves appeared in the range of 10 to 14 C, where reduced respiration was observed in specimens from the heated effluents. When A. CLAUSI from external areas were exposed to artificial thermal stress, they displayed a respiratory metabolism pattern similar to that of specimens sampled from the heated effluents. Experiments performed with warm-acclimated copepods revealed respiratory modifications similar to those observed in copepods from the heated effluent. These results are discussed in relation to the thermal conditions prevailing at the investigated site. (Auth)

<143>
Gehlbach, F.R., C.L. Bryan, and H.A. Reno, Baylor University, Department of Biology and Institute of Environmental Studies, Waco, TX

Thermal Ecological Features of CYPRINODON ELEGANS and GAMBUSIA NOBILIS, Endangered Texas Fishes.

<143> CONT.
Texas Jour. Sci., 30, 99-101 (1978)

Critical thermal maxima and preferred temperatures of the Comanche Springs pupfish (CYPRINODON ELEGANS) and Pecos gambusia (GAMBUSIA NOBILIS) were determined. Critical thermal maxima of male and female pupfish, tested in the afternoon, were 40.1 and 40.5 C, respectively. Respective values in the gambusias were 38.1 and 39.3 C. Pupfish tested in the afternoon tolerated a significantly higher CTM than those tested in the morning. Both species when tested alone in a thermal gradient showed a preference for 21 to 25 C in the morning and 26 to 30 C in the afternoon. When tested together C. ELEGANS chose a significantly lower thermal position than its preferendum in isolation. (ST)

<144>
Germany, R.D., and R.L. Noble, Texas A&M
University, Department of Wildlife and
Fisheries Sciences, College Station, TX

Population Dynamics of TILAPIA AUREA in Trinidad Lake, Texas.
Proc. 31st Ann. Conf. Southeast. Assn. Game & Fish Comm., 9 pp. (1977)

Population dynamics of TILAPIA AUREA in a 303 ha cooling reservoir of the Texas Power and Light Company's generating station were studied in order to determine potential yield to sport and commercial harvest. Total population of blue tilapia in December, 1974, was estimated as 4,856,963. Biomass was estimated to be 799,978 kg or 2,640 kg/ha. Of the total population, one-third were estimated to be Age I and two-thirds Age 0. Survival from Age I to II was calculated to be 7%. The potential yield of harvestable tilapia was calculated to be 1,629,501 fish weighing 521,153 kg. (ST)

<145>
Giattina, J.D., D.S. Cherry, S.R. Larrick, J.
Cairns, Jr., and K.L. Dickson, Virginia
Polytechnic Institute and State University,
Department of Biology, Blacksburg, VA

Avoidance Behavior of Fish to Intermittent Chlorination in Thermally Influenced Waste Water.
Assn. S.E. Biol. Bull., 27, 81 (Abstract only) (1978)

The avoidance response of fish populations to intermittent chlorination in a thermally influenced discharge was studied at the Glen Lyn power plant in southwestern Virginia. Field responses were observed over a temperature range from 36 to 16 C during summer to winter conditions. Avoidance was determined by comparing the number of fish seined at peak chlorine levels to the number found on days when chlorination was omitted. Chlorine concentrations in the field ranged from 0.000 to 0.710 mg/l total residual chlorine (TRC). Preliminary data, when considered through the whole temperature range, indicated that avoidance generally occurred at TRC concentrations greater than 0.15 (FRC greater than or equal to 0.04) mg/l). Field data for the most abundantly sampled species were compared to results obtained from avoidance responses carried out in a field laboratory located at the plant site. NOTROPIS SPILOPTERUS (spotfin shiner), the most abundant species sampled, apparently avoided field TRC concentrations greater than 0.15 mg/l (FRC greater than or equal to 0.03) while the laboratory threshold avoidance was 0.20-0.22 mg/l TRC (FRC = 0.07-0.14 mg/l) when tested at acclimation temperatures of 12, 18, and 30 C. Comparisons of the field and laboratory determinations are discussed. (Complete Text)

<146>
Gibbons, J.W., D.H. Bennett, G.W. Esch, and T.C.
Hazen, Savannah River Ecology Laboratory,
Aiken, SC; University of Idaho, College of
Forestry, Wildlife and Range Science,
Moscow, ID; Wake Forest University,
Department of Biology, Winston-Salem, NC

Effects of Thermal Effluent on Body Condition of Largemouth Bass.
Nature, 274, 470-471 (1978)

Body condition of largemouth bass collected from heated and unheated waters in Par Pond, South Carolina was compared over a ten year period. Body condition is an index used by fishery scientists for estimating fish well-being or fitness as well as the relative suitability of the habitat. Body condition (K) of an individual is established by the relationship K=10(E+5) W x L(E-3), where W=body weight (g) and L=standard length (mm). Mean maximum surface temperatures during reactor operations in summer months were 35 C in thermally-altered areas and 31 C in unaffected locations; in winter mean temperatures were 20 C in heated areas and 16 C at natural sites. Adult fish from unheated areas exhibited significantly higher mean condition factors than those from the heated area. Condition factors were usually higher in both heated and unheated areas during winter. Summer was the period of poorest body condition for bass in the heated area. (MU)

<147>
Gibson, R.J., Woods Hole Oceanographic
Institution, Woods Hole, MA

The Behavior of Juvenile Atlantic Salmon (SALMO SALAR) and Brook Trout (SALVELINUS FONTINALIS) with Regard to Temperature and to Water Velocity.
Trans. Amer. Fish. Soc., 107, 703-712 (1978)

Atlantic salmon parr and brook trout were observed in stream tanks at the Matamek Research Station, Quebec. In the autumn, at 10 C Atlantic salmon parr began sheltering in rubble, and at 9 C the majority had disappeared into hiding. Brook trout also had this tendency to hide at cold temperatures, but not as strongly as the salmon. In slow water flows (less than 5 cm/s), Atlantic salmon parr tended to hide in the rubble substrate at any temperature, and aggression decreased. In both slow and faster water velocities during summer and autumn the commonest agonistic act by Atlantic salmon parr was "charge and chase." Brook trout in July showed "nip" as the commonest agonistic act, but in September and October "approach" and "charge and chase" were more common, possibly due to aggression associated with spawning. Shade was attractive to both species in shallow water, but given the choice of a shallow (30 cm) tank with a shade cover, and a deeper (50 cm) tank with no shade, the majority of brook trout and Atlantic salmon selected the deeper tank. In one experiment in a shallow-water tank, turbulent water surface was more attractive to Atlantic salmon parr than shade. (Auth)

<148>
Ginn, T.C., New York University, New York, NY

An Ecological Investigation of Hudson River Macrozooplankton in the Vicinity of a Nuclear Power Plant.

<148>
<148> CONT.
Ph.D. Thesis, New York University, 292 pp. (1977)

Temperature and chlorine bioassays on selected Hudson River amphipods (GAMMARUS DAIBERI, G. TIGRINUS, G. FASCIATUS, and MONOCULODES EDWARDSI) showed that these organisms could survive typical Indian Point cooling water temperatures. The mysid NEOMYSIS AMERICANA had high mortalities during a 30-min, 8.3 C delta T at 25 C ambient temperature. The bioassay results were substantiated by generally high survivals of entrained amphipods and mortalities ranging from 30 to 60% of N. AMERICANA during the summer at the Indian Point plant. All species had higher immediate and latent mortalities during plant condenser chlorination. Power plant operation in the lower Hudson River has no adverse impact on the local amphipod populations. Impact on N. AMERICANA is minimized by the limited exposure of the Atlantic Coast populations to the Indian Point plant. (MU)

<149>
Ginn, T.C., and J.M. O'Connor, New York University Medical Center, Institute of Environmental Medicine, New York, NY

Response of the Estuarine Amphipod GAMMARUS DAIBERI to Chlorinated Power Plant Effluent.
Estuarine Coastal Marine Science, 6, 459-469 (1978)

The amphipod GAMMARUS DAIBERI was subjected to plume drifts and laboratory exposures to chlorinated power plant cooling water effluent. Behavioral reactions to unchlorinated and chlorinated effluent were examined in an avoidance trough. During plant chlorination, the amphipods survived I-h exposures to full-strength cooling water effluent delta T = 7.3 to 9.3 C, 0.05 m/l total chlorine). Test groups of G. DAIBERI drifted through the discharge plume during chlorination displayed no increased immediate or latent mortalities. One-hour static bioassays revealed an initial TL-50 value of 1.85 mg/l total chlorine, which decayed to 0.2 to 0.5 mg/l during the exposure period. At ambient temperatures of 26.4 to 26.6 C, the amphipods avoided unchlorinated effluent at delta T's greater than 3.3 C. At lower ambient temperatures (15.3 to 15.7 C), no avoidance was observed at 7.1 C delta T. Chlorinated discharge water was avoided by G. DAIBERI at both ambient temperatures. (Auth)

<150>
Ginn, T.C., G.V. Poje, and J.M. O'Connor, Tetra Tech., Inc., Lafayette, CA; New York University Medical Center, Tuxedo, NY

Survival of Planktonic Organisms Following Passage through a Simulated Power Plant Condenser Tube.
In Fourth National Workshop on Entrainment and Impingement, L.D. Jensen (Ed.). EA Communications, Melville, NY, (pp. 91-102), 424 pp. (1978)

An operational system is described that models the physical and chemical stresses encountered by entrained organisms in a power plant condenser. The individual effects and interactions of entrainment stresses may be examined by independently varying flow rate, pressure, temperature, and biocide concentration in duplicate condenser tubes. The following organisms were subjected to simulated condenser tube passage: striped bass larvae (MORONE SAXATILIS), carp (CYPRINUS CARPIO), phantom midge larvae (CHAOBORUS AMERICANUS), and the estaurine amphipod GAMMARUS TIGRINUS. For the fish species tested, the lethal effects of condenser passage were generally related to the magnitude of the temperature exposure. CHAOBORUS larvae experienced high mortalities, however, at subatmospheric pressures (0.71 atm) and a near-lethal delta-T. The responses to biocide injections during condenser passage are described, and the use of power plant condenser simulators for predictive purposes in entrainment research is evaluated. (Auth)

<151>
Gladfelter, E.H., R.K. Monahan, and W.B. Gladfelter, University of California, Department of Biology, Los Angeles, CA

Growth Rates of Five Reef-Building Corals in the Northwestern Carribbean.
Bull. Marine Sci., 28, 728-734 (1978)

Growth rates (linear extension) were measured for five species of reef-building corals in three environmental zones: backreef-lagoon, shallow forereef, and base of forereef on a bank barrier reef in the U.S. Virgin Islands during periods of highest (29.5 C) and lowest (26 C) annual water temperatures. Significant differences in linear extension rates as a function of temperature were seen in ACROPORA PALMATA and A. PROLIFERA. In the former, linear extension was significantly greater during the warm water period, except in the lagoon. Growth of A. PROLIFERA was greater in the lagoon at 29.5 C than at 26 C. (ST)

<152>
Godlewska-Lipowa, W.A., Polish Academy of Sciences, Department of Hydrobiology, Institute of Ecology, Lomianke, Poland

Effect of Heated Waters on Biocenosis of the Moderately Polluted Narew River. Microbiological Characteristics.
Pol. Arch. Hydrobiol., 23, 499-506 (1976)

The total number of bacteria and the value of bacterial biomass, the index of fecal pollution, the number of actinomyces and cellulolytic bacteria and their activity, and value of the organic matter destruction in the Narew River were examined before (1972) and after (1973) start up of the Ostroleka Power Plant-B (Poland). A tendency toward an increase of the examined microbiological indices was observed in 1973 as compared with the data of 1972. After the power station was operational, a rise of water temperature by 2 to 3 C was observed in the river together with a simultaneous increase of water pollution with the sewage and industrial wastes, which was indicated by higher values of the index of fecal pollution and a higher number of actinomyces. Both these factors--higher temperature and water pollution--were cumulated and exerted a straining effect on biocenosis of the bacteria which caused an increase in the bacterial microflora activity and this in turn has intensified microbiological processes connected with organic matter destruction. As a final result of these effects the sanitary conditions of the river have deteriorated. (Auth)

<153>
Goldberg, S.R., Whittier College, Department of Biology, Whittier, CA

Reproductive Cycle of the White Seaperch, PHANERODON FURCATUS (Embiotocidae).
Copeia, No. 2, 334-336 (1978)

A total of 225 specimens of white seaperch was examined from collections made during

<153> CONT.
1975-1976 and from a collection made May 11, 1977 during heat treatment processes at the Scattergood steam generating plant (Calif.). Although the fish in the 1977 collection had been exposed to temperatures of 23 to 32 C, no differences in gonadal histology were found when they were compared with specimens from the ichthyological collections of the Los Angeles Natural History Museum. (ST)

<154>
Goldman, J.C., J.M. Capuzzo, and G.T.F. Wong, Woods Hole Oceanographic Institution, Woods Hole, MA; Old Dominion University, Norfolk, VA

Biological and Chemical Effects of Chlorination at Coastal Power Plants.
CCNF-771070: In Water Chlorination: Environmental Impact and Health Effects, Volume 2, R.L. Jolley et al. (Eds.), Proceedings of the Second Conference on the Environmental Impact of Water Chlorination, Gatlinburg, TN, October 31-November 4, 1977. Ann Arbor Science, Ann Arbor, MI (pp. 291-305), 909 pp. (1977; 1978)

The results of two years of research on the effects of chlorine, ammonia, and temperature on entrained marine plankton and juvenile fish are presented. The research focused on two problems: the chemistry of chlorine in sea water and the combined effects of the three above stress factors on entrained organisms. Several conclusions and recommendations are given. The chemistry of chlorine in sea water is exceedingly complex. In the presence of ammonia, chloramines and bromamines are formed. These compounds are more persistent than free halogens and, hence, potentially more toxic. The use of the term chlorine residual as a measure of toxicity to marine organisms should be discouraged. Chlorination effects on phytoplankton at power plants appear to be a minimal problem compared to effects on larval zooplankton. There is a pronounced temperature synergism with chlorine and chloramine toxicity in the range 20 to 30 C (10 to 30 C for copepods). Growth rates of commercially important larvae such as lobsters appear to be seriously retarded after exposure to sublethal chlorine concentrations. The potential production of organochlorine compounds and their subsequent bioaccumulation throughout the food chain should be the subject of further research. (ST)

<155>
Golterman, H.L., Limnologisch Institute, Nieuwersluis, The Netherlands

Some Theoretical Considerations of Thermal Discharge in Shallow Lakes.
Intl. Jour. Ecol. Environ. Sci., 2, 159-175 (1976)

Increasing temperatures may effect net growth of phytoplankton positively or negatively depending on the species. Mineralization of dead phytoplankton will occur more rapidly, and may lead to faster growth rates, but does not necessarily lead to higher biomass. Larger effects may be expected on the selection of dominant species. The influence will have a synergistic effect with eutrophication, both stimulating the production of blue green algal blooms. Increasing temperatures will increase the number of generations of zooplankton per year, without increased food production. The effect on overwintering stages of the fauna may be detrimental, ultimately leaving open niches in the ecosystem. Other predator-prey relationships and competitive processes will be disturbed. The above mentioned points together with better known effects such as influence on spawning and migration and other physiologcial or even lethal effects, make heat disposal not permissible if this causes temperature elevations larger than those occurring naturally. Attention should be given especially to temperatures as the tolerance of the ecosystem is smaller during summer. (Auth)

<156>
Gorden, R.W., and C.B. Fliermans, University of Southern Colorado, Pueblo, CO; Savannah River Laboratory, Aiken, SC

Survival and Variability of ESCHERICHIA COLI in a Thermally Altered Reservoir.
Water Res. 12, 343-352 (1978)

ESCHERICHIA COLI survived and grew in a warm, monomictic reservoir receiving thermal effluent from a nuclear production reactor, which suggests that the presence of E. COLI in these aquatic systems is not an indication of recent fecal contamination. Known populations of E. COLI were placed in sterile diffusion chambers and suspended at various depths throughout the water column. Experiments were conducted during both ambient water conditions (reactor not operating) and thermally altered water conditions (reactor operating). E. COLI populations were observed for changes in density by using optical density and direct and indirect counting methods. During both ambient water and thermally altered water conditions, E. COLI survived and grew 2-3 weeks at each depth and at all stations. During thermal alteration, cell populations attained higher optical densities and maintained those densities for longer time periods than those during ambient water conditions. In addition, populations suspended in the hypolimnion generally maintained higher optical densities than those in the epilimnion. Data show that E. COLI survives and grows for extended periods of time while it is in diffusion chambers in both aerobic and anaerobic portions of the water column. (Auth)

<157>
Goss, L.B., University of Tennessee, Knoxville, TN

The Effects of Temperature on DAPHNIA PULEX Leydig and DAPHNIA MAGNA Straus.
Ph.D. Thesis, University of Tennessee, 134 pp. (1978)

DAPHNIA PULEX and DAPHNIA MAGNA were observed from birth to the end of the third adult instar at 10, 15, 20, 25, and 30 C and to the first adult instar at 5 C. At temperatures nearing their upper and lower tolerance limits, the number of immature instars increased and egg production decreased. Duration of development times decreased with increasing temperatures. First immature instar and adult female egg-carrying D. PULEX acclimated from 5 to 30 C, at 5 C intervals, and D. MAGNA acclimated from 5 to 25 C, at 5 C intervals, were instantaneously immersed at 30 and 35 C and observed for mortality. Adult female egg bearing D. PULEX and D. MAGNA were more sensitive to upper lethal temperatures than their respective immature forms. Results indicated that holding organisms in laboratory culture for extended time periods at constant temperatures could decrease their upper temperature tolerance limits as opposed to organisms exposed to fluctuating temperatures of natural environments. Respiration rates increased at increasing temperatures for both D. PULEX and D. MAGNA with the rates for D. PULEX being greater than and increasing approximately 1.5 times

<157> CONT.

faster than for D. MAGNA. Development rates for the two species followed the same trend. (Auth)(MU)

<158>

Griffith, J.S., Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN

Effects of Low Temperature on the Survival and Behavior of Threadfin Shad, DOROSOMA PETENENSE.

Trans. Amer. Fish. Soc., 107, 63-70 (1978)

Laboratory studies assessed the effects of gradual and rapid decreases in temperature on 9 to 14-cm long threadfin shad collected from a tributary of the Tennessee River. Fish acclimated to 15 C and exposed to temperatures cooling 1 C each 72 hours decreased in feeding activity and schooled less compactly beginning at 9 C. At lower temperatures they lost orientation and were insensitive to external stimuli, and none survived exposure to 4 C. Threadfin shad exposed to sudden cooling (2 to 5 C decreases in 8 hours) lost equilibrium in proportion to the magnitude of temperature decrease if minima of 4 to 6 C were reached. Cold-shocked fish that had lost equilibrium for 0.2, 30, and 90 minutes before being returned to warmer water experienced mortalities of 32, 79, and 94%, respectively. (Auth)

<159>

Griffiths, J.S., University of Toronto, Toronto, Canada

Effects of Acclimation and Abrupt Temperature Change on the Sustained Swimming Capacity and Metabolism of Brown Trout, SALMO TRUTTA (Linnaeus), and Bluegill, LEPOMIS MACROCHIRUS (Rafinesque).

Ph.D. Thesis, University of Toronto (1978)

Sustained swimming performance, active respiration, standard respiration and scope of brown trout, SALMO TRUTTA, and bluegill, LEPOMIS MACROCHIRUS, were investigated with respect to thermal acclimation and abrupt temperature change. The standard respiration requirements of brown trout and bluegills increased exponentially with test temperature and were modified by acclimation temperature such that given standard levels occurred at progressively higher test temperatures as acclimation temperatures increased. Active respiration of brown trout was maximized near 21 C, swimming performance and scope of adults were maximized at 15.5 C to 18 C. Bluegill active respiration was maximized at temperatures from 32 C to the upper lethal limit (34 C). On the basis of scope, swimming performance, growth and final temperature preferendum, physiological optima of 15 C to 18 C for brown trout and approximately 29 C for bluegill were indicated. (Auth)(ST)

<160>

Groberg, W.J., Jr., R.H. McCoy, K.S. Pilcher, and J.L. Fryer, Oregon State University, Department of Microbiology, Corvallis, OR

Relation of Water Temperature to Infections of Coho Salmon (ONCORHYNCHUS KISUTCH), Chinook Salmon (O. TSHAWYTSCHA), and Steelhead Trout (SALMO GAIRDNERI), with AEROMONAS SALMONICIDA and A. HYDROPHILA.

Jour. Fish. Res. Bd. Can., 35, 1-7 (1978)

Juvenile steelhead trout (SALMO GAIRDNERI), coho salmon (ONCORHYNCHUS KISUTCH), and spring chinook salmon (O. TSHAWYTSCHA) were infected by intraperitoneal or intramuscular injection with AEROMONAS SALMONICIDA or A. HYDROPHILA at seven temperatures from 3.9 to 20.5 C. At 3.9 and 6.7 C, mortality in fish infected with A. SALMONICIDA varied from 2 to 26% among the three salmonid species. At 20.5 C 93 to 100% of these animals died within two or three days; at 6.7 C or lower the fish survived for 12 to 23 days. Growth of A. SALMONICIDA in vitro was influenced by temperature in a manner very similar to its influence on the in vivo infection. Comparable experiments with A. HYDROPHILA gave results much like those with A. SALMONICIDA, though some differences were noted. At a temperature of 20.5 C, percent mortality ranged from 64 to 100%. At 9.4 C or below no deaths attributed to A. HYDROPHILA occurred. Fatally infected fish died more rapidly at the higher temperatures. (Auth)

<161>

Gross, H.P., University of Oxford, Department of Zoology, Oxford, England

Observations on the Geographic Variation of the Marine Coastal Fish SPINACHIA SPINACHIA.

Marine Biol. (W. Ger.), 47, 297-302 (1978)

Meristic variations of the fifteen spined stickleback collected along the European coastline are reported. Total vertebral number, dorsal and anal fin ray numbers, and gillraker number showed similar patterns of variation with latitude. Counts of these characters declined from 13 to 16 C. An inflection point appeared to occur at 16 C with vertebral number becoming positively correlated with further increases in temperature. Thus the relationship between breeding season temperatures and these characters appeared to be V-shaped or curvilinear. (ST)

<162>

Grove, D.J., L.G. Loizides, and J. Nott, Marine Science Laboratories, Menai Bridge, Gwynedd, United Kingdom

Satiation Amount, Frequency of Feeding and Gastric Emptying Rate in SALMO GAIRDNERI.

Jour. Fish Biol., 12, 507-516 (1978)

Rainbow trout consumed food in direct proportion to their body weight although the ration increased with temperature (studied over the range 7 to 12 C). Satiation time varied as 0.031 weight + 0.868 temperature + 29.145 min. Appetite after deprivation returned in close conjunction with gastric emptying, as judged from serial slaughter studies. Trout trained to operate demand feeders ate less but exhibited feeding rhythms even under conditions of constant illumination. Radiography showed that these rhythms closely paralleled gastric emptying. When offered food diluted with kaolin, the fish compensated by eating more food. This was achieved by increasing feeding frequency caused by a more rapid rate of gastric emptying. (Auth)

<163>

Gruninger, T.L., C.[illegible] Murphy, and J.C. Britton, Texas Christian University, Department of Biology, Fort Worth, TX

Macroparasites of Fish from Eagle Mountain Lake, Texas.

Southwestern Naturalist, 22, 525-535 (1977)

From September, 1973, through October, 1974, 397 fish representing 9 species and 3 families were collected from Eagle Mountain Lake (a cooling water source for a steam-electric plant operated by the Texas

<163> CONT.

Electric Service Company). The following fish species were examined: APLODINOTUS GRUNNIENS, ICTALURUS PUNCTATUS, MICROPTERUS SALMOIDES, M. PUNCTULATUS, POMOXIS ANNULARIS, LEPOMIS GULOSUS, L. MACROCHIRUS, L. MEGALOTIS, and L. MACROLOPHUS. Thirty-two species of parasites representing 22 families and 26 genera were recovered. Seventy-three percent of the fish examined harbored at least one species of helminth, annelid, mollusk, or crustacean parasite. Parasite loads were light and did not appear to pose a serious threat to the species of fish studied. A comparison of fish collected from heated waters with those taken outside the influence of thermal loading suggests little effect of thermal loading upon incidence of parasitism when fish are permitted free access to both areas. (Auth)

<164>
Guerin-Ancey, O., Station Marine d'Endoume, Marseille, France

Experimental Study of the Nitrogen Excretion of Bass (DICENTRARCHUS LABRAX) during Growth. II. Effects of Starvation on the Excretion of Ammonia and Urea.
Aquaculture, 9, 187-194 (1976)

The effects of starvation and temperature on ammonia and urea excretion in the bass (DICENTRARCHUS LABRAX L; groups 0, 1, and 2) were examined for fishes acclimated to 16, 18, and 20 C. Ammonia and urea excretion decreased during the seven-day period of starvation to a constant: the Endogenous Nitrogen Excretion (ENE). ENE is 72 mg/N/kg/24 h of ammonia and 12 mg N/kg/24 h of urea. ENE is the same for age groups 0, 1, and 2 and occurs later at 16 C than at 20 C. The percentage of urea excreted increased during the starvation period. Nitrogen reserves were calculated to be greater in younger fish and in autumn. (Auth)

<165>
Guerin-Ancey, O., Station Marine d'Endoume, Marseille, France

Experimental Study of the Nitrogen Excretion of Bass (DICENTRARCHUS LABRAX) during Growth. I. Effects of Temperature and Weight on the Excretion of Ammonia and Urea.
Aquaculture, 9, 71-80 (1976)

The effects of temperature and body weight on ammonia and urea excretion were examined for fishes acclimated to 12, 14, 16, 18, 20, 22, and 24 C. Ammonia and urea excretion rates were very high at the highest temperatures and decreased with decrease in temperature. Between 18 and 24 C, ammonia excretion rates were equal while urea excretion rates increased with temperature. The excretion of age groups 0, 1, and 2 was studied; the younger the fishes, the more important were the excretion rates. (Auth)

<166>
Guma'a, S.A., Windermere Laboratory, Freshwater Biological Association, Windermere, England

The Effects of Temperature on the Development and Mortality of Eggs of Perch, PERCA FLUVIATILIS.
Freshwater Biology, 8, 221-227 (1978)

The rate of development and mortality of perch PERCA FLUVIATILIS was studied at ten different constant temperatures. The rate of development was inversely related to the incubation temperature, whereas the rate of mortality was directly related to the incubation temperature. The sum of heat

required for 10, 50 and 90% of the eggs to hatch was found to be constant, regardless of the incubation temperature, with mean values (with 95% confidence limits) of 91.4 (83.3-102.0) degree-days above 4.6 C for 10% hatched, 97.0 (90.9-104.2) degree-days above 4.9 C for 50% hatched and 101.0(94.3-108.7) degree-days above 5.0 C for 90% hatched. Mortality among the different embryological stages was highest for the pre-hatching stage (i.e. when eye-pigment has been formed) at all temperatures. High mortality among the early stages occurred at temperatures below 8 C and above 12 C. (Auth)

<167>
Haag, R.W., and P.R. Gorham, University of Alberta, Department of Botany, Edmonton, Canada

Effects of Thermal Effluent on Standing Crop and Net Production of ELODEA CANADENSIS and Other Submerged Macrophytes in Lake Wabamun, Alberta.
Jour. Appl. Ecol., 14, 835-851 (1977)

The dry weight production of aquatic macrophytes was measured over a two year period at several depths in Lake Wabamun, Canada. Production was measured at a control site and in an area receiving effluent from the Wabamun generating station. Standing crop of all macrophytes was higher in the thermal mixing zone in winter, with ELODEA CANADENSIS being the dominant species. ELODEA dominated early spring production and increased in growth after spring turnover. ELODEA comprised one-third of the maximum standing crop at the control site in the first year and was absent the second year. Thus changes in the species composition of submerged macrophytes in heated areas of the lake did not spread to unheated areas. (ST)

<168>
Hackney, C.T., W.D. Burbanck, and O.P. Hackney, Emory University, Departments of Biology and Biometry and Statistics, Atlanta, GA

Biological and Physical Dynamics of a Georgia Tidal Creek.
Chesapeake Sci., 17, 271-280 (1976)

The physical and biological characteristics of five stations in and near a tidal creek were studied for 18 months. Tidal creeks and tidal rivers are differentiated and defined. Diel fluctuations of dissolved oxygen and temperature were greatest and tidal-induced salinity oscillations the least at the headwaters of the creek. Small salinity oscillations promoted a high overall diversity of fishes at the headwaters of the creek, even though few fish species maintained permanent populations there. Juvenile fishes were abundant in the summer and fall. Extreme temperature (33.5 C) and low dissolved oxygen levels prompted a migration of fishes from these areas in late summer. Only FUNDULUS HETEROCLITUS remained during high temperature and low dissolved oxygen conditions. Permanent fish populations were found at the mouth of the creek and in an adjacent tidal river. (Auth)(ST)

<169>
Hahn, P.K.J., University of Idaho, Moscow, ID

Effects of Fluctuating and Constant Temperatures on Behavior of Steelhead Trout (SALMO GAIRDNERI).
Ph.D. Thesis, University of Idaho, 142 pp. (1977)

Temperature was found to affect population

<169>
<169> CONT.

density in the laboratory. At a constant temperature of 13.5 C, equal numbers of fish were found at the constant temperature and at fluctuating temperatures; at a constant temperature of 18.5 C, twice as many fish were found at the fluctuating temperatures; at a constant temperature of 8.5 C, half as many fish were found at the fluctuating temperatures. Rates of aggressive acts did not differ in fluctuating and constant 13.5 C temperatures, more acts occurred in fluctuating than in 18.5 C temperatures, and slightly fewer acts occurred in fluctuating than in 8.5 C temperatures. After comparing behavior between experiments within temperatures, it was suggested that density had a larger impact on rate of aggression than did temperature. Higher water temperatures significantly increased feeding and nonassignable movements when compared to lower temperatures. (Auth) (HU)

<170>
Hall, L.W., Jr., A.L. Buikema, Jr., and J. Cairns, Jr., Virginia Polytechnic Institute and State University, Department of Biology and Center for Environmental Studies, Blacksburg, VA

The Effects of a Simulated Refinery Effluent on the Grass Shrimp, PALAEMONETES PUGIO.
Arch. Environ. Contam. Toxicol., 7, 23-35 (1978)

Duplicate static bioassays were conducted using a simulated refinery effluent on the grass shrimp (PALAEMONETES PUGIO, HIPPOLYTE sp.) with the LC-50 values recorded at 4-, 8-, 24-, 48-, and 96-hr intervals. The simulated refinery effluent contained phenol (0.10 mg/l), sulfide (0.17 mg/l), chromium (0.25 mg/l), ammonia (10 mg/l), No. 2 fuel oil (10 mg/l), and kaolinite (20 mg/l). This arbitrary reference mixture (ARM) contains approximately the concentration of compounds recommended by EPA for 1977. Of the six ARM components, No. 2 fuel oil was the most toxic followed in decreasing order by sulfide, ammonia, phenol, chromium, and kaolinite. Temperature (10 to 30 C) was the most important environmental variable affecting short term toxicity of the ARM to the grass shrimp, with greater mortalities at the higher temperatures. Light intensity, photo-period, and salinity had no significant effect. There was no difference in sensitivity of grass shrimp collected from five locations along the gulf and eastern coasts of the United States. Similarly, there was no difference in the response of two grass shrimp genera, PALAEMONETES and HIPPOLYTE to the ARM and there were no differences among the three species of PALAEMONETES tested. In comparing the sensitivities of the two genera of grass shrimp and the pinfish (LAGODON RHOMBROIDES) to the ARM, the grass shrimp were more sensitive. (Auth)

<171>
Hall, L.W., Jr., C.H. Hocutt, and J.R. Stauffer, Jr., University of Maryland, Center for Environmental and Estuarine Studies, Applachian Environmental Laboratory, Frostburg State College, Frostburg, MD

Implication of Geographic Location on Temperature Preference of White Perch, MORONE AMERICANA.
Jour. Fish. Res. Bd. Can., 35, 1464-1468 (1978)

Temperature preference tests were conducted on freshwater white perch (MORONE AMERICANA) collected from Albemarle Sound, SC; Wicomico River, MD; and Mullica River, NJ. Collection temperatures for each population were 25 C and acclimation temperatures used in temperature preference tests were 6, 12, 18, 24, 30, and 33 C. Analysis of covariance determined that a significant difference exists in the temperature preference of the white perch populations tested. The calculated final temperature preferenda using linear regression for North Carolina, Maryland, and New Jersey populations were 32.4, 28.9, and 29.6 C, respectively. Calculated final temperature preferenda using the quadratic equation for North Carolina, Maryland, and New Jersey populations were 31.6, 29.3, and 29.2 C, respectively. Visual estimation yielded final temperature preference values of 32.5, 30.6, and 29.6 C for North Carolina, Maryland, and New Jersey populations, respectively. (Auth)

<172>
Hanumante, M.M., and G.K. Kulkarni, Marathwada University, Department of Zoology, Aurangabad, India

Effect of Thermal Acclimation on Gametogenesis of the Indian Freshwater Leech, POECILOBDELLA VIRIDIS (Blanchard).
Hydrobiologia (Den.), 61, 183-185 (1978)

The effect of thermal acclimation for 15 days on the gametogenesis of POECILOBDELLA VIRIDIS was studied. Leeches conditioned at laboratory temperature (25.5 to 27.5 C), when warm acclimated (32.0 C), displayed a significant increase in the percentage of oocytes having a diameter of 12.5 u and 15.0 u and in the percentage of fully mature sperm clusters over the controls, whereas cold acclimation (10.0 C) did not induce significant changes in the oocytes and sperm clusters. Thus it is concluded that in P. VIRIDIS temperature is of paramount importance in initiating gametogenesis. (Auth)

<173>
Hargreaves, B.R., University of California, Berkeley, CA

Growth of Two Marine Mussels, MYTILUS EDULIS and MYTILUS CALIFORNIANUS.
Ph.D. Thesis, University of California, 126 pp. (1977)

Growth of submerged, caged mussels, MYLILUS EDULIS and M. CALIFORNIANUS was measured for a period of two years in two temperature regimes at Morro Bay, California. Growth was measured in Morro Bay and in the thermal outfall of a coastal power plant. Tissue weight change was used as a measure of growth. For most experimental periods the growth data fit a linear regression of log tissue weight change on log initial tissue weight. Monthly and seasonal deviations from the linear regression were noted. At the control site average temperatures ranged from approximately 11 C during winter to approximately 15 C in summer. Within the power plant outfall, at temperatures above 20 to 22 C, growth was slower than at the control site. Below 20 to 22 C, growth was similar at outfall and intake. For M. EDULIS, almost no growth occurred in the outfall above 24 C, and significant mortalities occurred in one experiment when the mean temperature exceeded 27 C. For M. CALIFORNIANUS, growth was reduced, but still significant at a mean outfall temperature of 26 C. (ST)

<174>
Harmelin-Vivien, M.L., J.G. Harmelin, and J. Vacelet, Station Marine d'Endoume et Centre d'Oceanographie, Marseille, France

Study of the Fish Fauna in the Thermal Release Zone of the Martigues-Ponteau Power Plant.
Tethys, 8, 111-114 (1976)

<174> CONT.

In situ study of the fish fauna by direct quantitative estimation, was made in a zone affected by thermal release from a littoral power plant. This zone was compared with a near-by area apart from heated water influence. The ichthylogical fauna of the discharge zone was characterized by a qualitative poorness, especially for sedentary species. The main part of the stock consisted of mid-water (nektonic and nektobenthic) species. In this fish category, the percentage of juveniles was particularly high. Rapid fluctauations of the stock were observed according to meteorological peculiarities. (Auth)

<175>
Harrell, R.D., and D.G. Cloutman, Duke Power Company, Environmental Sciences Unit, Huntersville, NC

Distribution and Life History of the Sandbar Shiner, NOTROPIS SCEPTICUS (Pisces: Cyprinidae).
Copeia, No. 3, 443-447 (1978)

Spawning of the sandbar shiner in the Kings Creek Drainage, SC, occurred from late May through early July at water temperatures of 18 to 24 C and peaked in June at 22 C. Most fish reached sexual maturity when they were two years old. No specimens over three years of age were collected. Diet consisted primarily of insects. Sandbar shiners inhabit clear upland streams of eastern North Carolina and eastern Georgia. (ST)

<176>
Harris, R.E., and W.A.G. Charleston, Massey University, Veterinary Faculty, Palmerston North, New Zealand

Some Temperature Responses of LYMNAEA TOMENTOSA and L. COLUMELLA (Mollusca: Gastropoda) and Their Eggs.
N.Z. Jour. Zool., 4, 45-49 (1977)

Under similar laboratory conditions LYMNAEA COLUMELLA invariably produced more eggs than L. TOMENTOSA at temperatures up to 24 C. Both species oviposited at 5 C, and a single egg capsule of L. COLUMELLA was produced at 2 C. The minimum temperature at which eggs would develop and hatch was between 5 and 10 C; eggs of both species underwent some development at 5 C, but did not survive to hatching. Temperatures above 30 C were lethal to eggs of L. TOMENTOSA; L. COLUMELLA eggs developed normally at 34.5 C, but 36 C was lethal. A polynomial regression describing the relationship between the logarithm of incubation time and temperature was linear between approximately 15 and 23 C for both species. Below 15 C development was slower than predicted by a linear model. The development of L. COLUMELLA eggs was most rapid and nearly constant between 25 and 34.5 C. Development times for L. TOMENTOSA eggs increased at 28 and 29 C as the upper lethal limit of 30 C was approached. At all temperatures but 20 C, L. COLUMELLA eggs developed significantly more rapidly than those of L. TOMENTOSA. The proportion of eggs that hatched at room temperature or at 25 to 27 C after various periods of chilling at 4 C was greater for L. COLUMELLA than for L. TOMENTOSA. When snails were subjected to various temperatures above 37 C for 30 min the LT50 for L. TOMENTOSA was found to be between 42 and 43.5 C; and that for L. COLUMELLA between 40.5 and 42.C. (Auth)

<177>
Harrison, E.J., State University of New York at Buffalo

<174>

Comparative Ecologic Life Histories of Sympatric Populations of ESOX LUCIUS and ESOX MASQUINONGY of the Upper Niagara River and Its Local Watershed.
Ph.D. Thesis, State University of New York at Buffalo, 326 pp. (1978)

Northern pike (ESOX LUCIUS) and muskellunge (ESOX MASQUINONGY) were collected from the upper Niagara River and its tributaries during 1975 and 1976 by trap nets, seines, electrofishing, and creel surveys. Length, weight, age, growth, maturity, spawning, infestation, and population size were studied. Most northern pike spawned before water temperature reached 10 C. Scant evidence of river spawning was found. Most muskellunge spawned in the Niagara River when water temperatures were 16 to 18 C. Current velocities of 0.2 m/sec and depths of 1 to 2 m were typical of spawning areas. (MU)

<178>
Hart, R.C., and I.A. McLaren, Dalhousie University, Biology Department, Halifax, Nova Scotia, Canada

Temperature Acclimation and Other Influences on Embryonic Duration in the Copepod PSEUDOCALANUS sp..
Marine Biol. (W. Ger.), 45, 23-30 (1978)

Embryos of PSEUDOCALANUS sp. captured near Halifax, Nova Scotia, Canada, in spring took longer to develop than did those from the warmer waters of summer and autumn. This was related to the larger size of females and their eggs in the colder seasons. An experiment revealed size-assortative mating and the influence of male size as well on embryonic duration. The seasonal change is contrary to the slight reduction of embryonic duration after short-term cold acclimation of females in the laboratory. There is no evidence that embryos in the cold season develop more rapidly than expected from the overall relationship between embryonic duration and female size. However, they do, like embryos after short-term cold acclimation, develop relatively more rapidly at low temperatures; i.e., there is clockwise "rotation" of the rate-temperature response, equivalent to the temperature adaptation that has been demonstrated among species of copepods. This seasonal "rotation" may also be related to seasonal variations in size, since larger females from a given season produce embryos that show such "rotation". Thus, there is no evidence for seasonal compensation as a consequence of temperature acclimation underlying changes that are attributable to differences in size. Evidently there is also a strong, genetical component in duration of development of embryos produced by individual females. (Auth)

<179>
Hatch, J.T., DePauw University, Zoology Department, Greencastle, IN

The Responses of the Fish Fauna of Little Three Mile Creek and the Ohio River to a Thermal Effluent.
M.A. Thesis, DePauw University, 91 pp. (1973)

A three year study on the response of the fish fauna in Little Three Mile Creek and the Ohio River to the thermal effluent from the J.M. Stuart Electrical Generating Station is reported. Areas above and below the discharge, the discharge canal (Little Three Mile Creek) and a control creek were compared. While temperatures in the river never reached a critical point during the study, definite responses to the thermal

<179>
<179> CONT.

effluent were elicited. Channel catfish, carpsuckers, longnose gar, carp, smallmouth buffalo, and white bass were strongly thermophilic. Freshwater drum, skipjack herring, and gizzard shad were moderately thermophilic. Largemouth and spotted bass were moderately thermophobic. Redhorse, suckers, and goldeye were strongly thermophobic. At the community level, fish displayed a strong preference for the thermally modified waters, especially in the fall. Channel catfish, carp, and carpsuckers overwintered in the effluent canal. All fish were eliminated from the effluent canal in summer. No measurable deleterious effects upon fish in the Ohio River were detected. (Auth) (ST)

<180>
Hauser, W.J., University of California-Riverside,
Division of Biological Control, Riverside, CA

Temperature Requirements of TILAPIA ZILLII.
Calif. Fish & Game, 63, 228-233 (1977)

Laboratory experiments and field observations were combined to define the temperature requirements of TILAPIA ZILLII, an African cichlid used for biological control of aquatic weeds in irrigation systems in southern California. The optimal temperature range for feeding, growth, and spawning is between about 20 and 32 C. Deaths occur at water temperatures above 39.5 C and below 11.2 C, but the extreme upper and lower lethal temperature tolerance limits are 42.5 C and 6.5 C, respectively. In nature, however, few, if any, T. ZILLII would be expected to survive a 2-week exposure to 13.0 C water temperature. Because of its thermal requirements, the value of T. ZILLII as a biological control agent for aquatic weeds in southern California irrigation canals is lessened. (Auth)

<181>
Haven, K.F., and T.C. Ginn, Tetra Tech., Inc.,
Lafayette, CA

A Mathematical Model of the Interactions of an Aquatic Ecosystem and a Thermal Power Station Cooling System.
In Fourth National Workshop on Entrainment and Impingement, L.D. Jensen (Ed.). EA Communications, Melville, NY, (pp. 321-342), 428 pp. (1978)

A mathematical model incorporating state of the art knowledge has been developed to simulate the interaction of an aquatic community and a thermal power station as part of a methodological development for the Electric Power Research Institute to assess the integrated effects of multiple power stations on a single waterbody. The methodology is designed for long-range planning applications and includes an aquatic ecosystem model, a planning model, and the thermal power plant cooling system simulation model (CSSM). The CSSM has four major components (a cooling system operations model, an intake model, a plant passage model, and a plume model) and is designed to calculate both the physical operating parameters of each power station and the power plant-induced mortality rates in the intake system, within the plant and the discharge system, and in the thermal plume. Separate consideration is given to in-plant thermal mortality, biocide-induced mortality, and pressure- and mechanical stress-induced mortality. Additionally, the effect of intake location, intake velocity profile, intake fish directional bypass devices (louvers), and alternate main screen designs and modes of operation on impingement and entrainment are calculated. Finally, the effects of plant discharge (heat and residual chlorine) on organisms entrained into the thermal plume are calculated. (Auth)

<182>
Haynes, J.M., University of Minnesota,
Minneapolis, MN

Movement and Habitat Studies of Chinook Salmon and White Sturgeon.
Ph.D. Thesis, University of Minnesota, 166 pp. (1978)

As part of a study on the movement and habitat of chinook salmon in the Snake River and white sturgeon in the Hanford reach of the Columbia River, seasonal movements of white sturgeon were related to water temperatures. Movements began in June when water temperatures exceeded 13 C and ceased when temperatures dropped below 13 C in October. Data from sturgeon carrying temperatures sensing transmitters suggested diurnal movement cycles. Sturgeon environmental temperatures were significantly higher than main current temperatures from late afternoon until midnight, suggesting sturgeon movements into shallow, warm water areas, possibly to feed, as darkness approached. Environmental temperatures declined after midnight, and especially after sunrise, indicating movements back to the cooler, main river channel. (ST)

<183>
Haynes, J.M., R.H. Gray, and J.C. Montgomery,
Freshwater Sciences, Ecosystems Department,
Battelle Pacific Northwest Laboratories,
Richland, WA

Seasonal Movements of White Sturgeon (ACIPENSER TRANSMONTANUS) in the Mid-Columbia River..
Trans. Amer. Fish. Soc., 107, 275-280 (1978)

Twenty-nine white sturgeon (ACIPENSER TRANSMONTANUS) were instrumented in 1975 and 1976 with separately identifiable radio transmitters to study seasonal movements in the mid-Columbia River, southeastern Washington. Tagged fish remained in free-flowing areas of the river and were inactive in winter. Movements occurred in summer and early fall. Activity appeared related to water temperature and sturgeon size. Movements from release locations began in mid-June when water surface temperatures ranged from 13 to 14 C. Movements ceased in mid-October when water temperatures were approximately 15 C. (Auth) (ST)

<184>
Hazen, T.C., Wake Forest University,
Winston-Salem, NC

The Ecology of AEROMONAS HYDROPHILA in a South Carolina Cooling Reservoir.
Ph.D. Thesis, Wake Forest University, Winston-Salem, NC, 259 pp. (1978)

The distribution and abundance of AEROMONAS HYDROPHILA were measured in Par Pond, a 1012 ha cooling reservoir that receives heated effluent from the Savannah River Plant (South Carolina). Of the variables measured, temperature was the only one observed to alter the density of A. HYDROPHILA. Within the reservoir higher temperatures were positively correlated with higher densities of A. HYDROPHILA. The distribution of A. HYDROPHILA in the geothermal water of Yellowstone National Park was similar to the distribution of A. HYDROPHILA in the reactor canals of the

<184> CONT.
Savannah River Plant; the bacteria were not present at temperatures above 45 C and were most dense at temperatures between 29 and 35 C. The incidence of red-sore disease among bass was directly correlated to stress, induced by elevated water temperature, and to density of AEROMONAS HYDROPHILA. (MT)

<185>
Hazen, T.C., and G.W. Esch, Wake Forest University, Department of Biology, Winston-Salem, NC

Observations on the Ecology of CLINOSTOMUM MARGINATUM in Largemouth Bass (MICROPTERUS SALMOIDES).
Jour. Fish Biol, 12, 411-420 (1978)

Over a 15-month period, approximately 13,500 centrarchids from Par Pond cooling pond at the Savannah River Plant were examined for infection with metacercaria of CLINOSTOMUM MARGINATUM. Except for largemouth bass, infection percentages among five other centrarchids were less than one percent. Among bass, infection varied seasonally, being highest from January to June and lowest in July and August. Neither body condition nor length of the bass were related to infection percentage or metaceracria density. Infection percentage could not be related to the influence of thermal effluent. Infection percentages did vary from location to location within the Par Pond system. A significant rank correlation could be established between infection percentage and the amount of littoral zone present in the locality from which the bass were taken. It is suggested that the local "bay effects" are the result of limited home and foraging ranges of the bass in relation to the amounts of littoral zone present in various locations of the reservoir. (Auth) (ST)

<186>
Hazen, T.C., G.W. Esch, A.B. Glassman, and J.W. Gibbons, Wake Forest University, Department of Biology, Winston-Salem, NC

Relationship of Season, Thermal Loading and Red-Sore Disease with Various Haematological Parameters in MICROPTERUS SALMOIDES.
Jour. Fish Biol., 12, 491-498 (1978)

Largemouth bass (MICROPTERUS SALMOIDES) were collected from ambient and thermally altered (10 C above ambient) areas of Par Pond and checked for red-sore disease (caused by tho bacterium, AEROMONAS HYDROPHILA and the ciliate, EPISTYLIS sp.). Of several parameters measured (hematocrit, hemoglobin, iron, total iron-binding capacity, thyroxine, sodium and potassium), only the total iron-binding capacity was significantly higher in bass with red-sore disease. Bass from thermally altered locations had consistently higher hematocrits during both summer and winter. Bass collected in summer had higher levels of circulating iron and higher thyroxine levels than bass collected in winter. These results are discussed in terms of their relationship to red-sore disease, season, and the impact of thermal effluent. (ST)

<187>
Heath, A.G., Virginia Polytechnic Institute and State University, Department of Biology, Blacksburg, VA

Toxicity of Intermittent Chlorination to Freshwater Fish: Influence of Temperature and Chlorine Form.
Hydrobiologia (Den.) 56, 39-47 (1977)

Fingerling size SALMO GAIRDNERI, ONCORHYNCHUS KISUTCH, NOTEMIGONUS CRYSOLEUCAS, CYPRINUS CARPIO, and ICTALURUS PUNCTATUS were exposed in the laboratory three times daily for up to seven days to pulses of either free chlorine or monochloramine. This regime simulated conditions often encountered in the outfall of steam electric generating plants which chlorinate intermittently. LC50's, LT50's, and response isopleths giving various percentage mortalities, were computed from the bioassays. S. GAIRDNERI, O. KISUTCH, and I. PUNCTATUS were the most sensitive to both types of chlorine. C. CARPIO were most resistant and the N. CRYSOLEUCAS were intermediate in sensitivity. Temperature had relatively little effect on the toxicity of intermittent chlorine to the species tested. In this type of test regime, free chlorine was three to fourteen-fold more toxic (depending on the species) than monochloramine. Water quality criteria for the protection of fish should, in the future, take this differential toxicity into consideration. (Auth)

<188>
Heath, A.G., Virginia Polytechnic Institute and State University, Blacksburg, VA

Influence of Chlorine Form and Ambient Temperature on the Toxicity of Intermittent Chlorination to Freshwater Fish.
Conf-771070; In Water Chlorination: Environmental Impact and Health Effects, Volume 2, R.L. Jolley et al. (Eds.), Proceedings of the Second Conference on the Environmental Impact of Water Chlorination, Gatlinburg, TN, October 31-November 4, 1977. Ann Arbor Science, Ann Arbor, MI (pp. 123-133), 909 pp. (1977; 1978)

The effects of temperature on the toxicity of free chlorine and monochloramine to rainbow trout (SALMO GAIRDNERI), coho salmon (ONCORHYNCHUS KISUTCH), golden shiner (NOTEMIGONUS CRYSOLEUCAS), bluegill (LEPOMIS MACROCHIRUS) and channel catfish (ICTALURUS PUNCTATUS) were analyzed using continuous flow bioassay procedures. The fish were exposed at 8 h intervals to spike-type chlorine pulses. Residual oxidant concentrations, measured by amperometric titration, reached a maximum value about 45 min after the start of each pulse, then dropped back to zero in 1-2 h. Tolerance limits were measured as median lethal concentrations based on the peak residual oxidant values. Test temperatures were identical to acclimation temperatures. In free chlorine tests lasting 96 h or longer, temperature had little effect on LC50 values, but in shorter tests there were some significant differences in the tolerance limits at the different temperatures. LC50 values for rainbow trout were slightly lower at 12 C than at 5 or 17 C; those for channel catfish and golden shiners were lower at 24 C than at 5 C and those for bluegills slightly lower at 15 and 25 C than at 6 and 32 C. In the monochloramine tests there was no temperature effect on coho salmon tolerance limits (at 6 and 12 C) and channel catfish (tested at 6 and 24 C) but golden shiners had higher LC50 values at 24 C than at 5 C. (DHO)

<189>
Hecker, B., State University of New York at Stony Brook

Adaptive Responses in HYDRA OLIGACTIS.
Ph.D. Thesis, State University of New York, 160 pp. (1978)

The responses of HYDRA OLIGACTIS to temperature and food availability were

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<189> CONT.

investigated. Stock cultures maintained at 13, 20, and 27 C were subjected to feeding intervals of 1,2,4, and 8 days or were shifted to the other two temperatures. Hydra cultures maintained at a low temperature (13 C) consisted of large individuals with a low intrinsic rate of increase. They reproduced sexually if provided with large amounts of food and were relatively resistant to starvation. Buds produced by these hydras reproduced immediately when moved to warmer water and also had a high probability of floating. Cultures maintained at the highest temperature consisted of small individuals with a high rate of intrinsic increase. They did not reproduce sexually and were susceptible to starvation. Buds subjected to cooler temperature suffered a delay in reproduction and had a low probability of floating. Hydra maintained at the intermediate temperature were medium sized and did not reproduce sexually. Their buds floated only when the interval between feedings was increased. (ST)

<190>
Heidinger, R.C., Southern Illinois University, Fisheries Research Laboratory and Department of Zoology, Carbondale, IL

Potential of the Threadfin Shad as a Forage Fish in Midwestern Power Cooling Reservoirs.
Trans. Ill. State Acad. Sci. 70, 15-25 (1977)

Threadfin shad (DOROSOMA PETENENSE) were successfully introduced into Southern Illinois Lake of Egypt in spring 1971. Adult shad overwintered for five years in the warm water discharge of a 100 megawatt fossil fuel power plant. No serious problems due to the shad introduction were encountered. Before the introduction, few white crappie (POMOXIS ANNULARIS) reached 200 g and the major diet of these crappie appeared to be insects. Within six years after introduction, a strong crappie fishery developed on the lake. After six years, the average calculated weights of white crappie were 2, 38, 100, 199, 546 and 896 g, at annulus 1-6, respectively. White crappie between 150 to 240 mm total length fed heavily on threadfin shad only in the fall. White crappie larger than 240 mm total length utilized threadfin shad throughout spring, summer and fall. (Auth)

<191>
Heip, C., N. Smol, and V. Absillis, State University of Gent, Department of Zoology, Gent, Belgium

Influence of Temperature on the Reproductive Potential of ONCHOLAIMUS OXYURIS (Nematoda: Oncholaimidae).
Marine Biol. (W. Ger.), 45, 255-260 (1978)

The large nematode ONCHOLAIMUS OXYURIS Ditlevsen, 1911 is a dominant predator in a shallow polyhaline brackish-water pond in Belgium. The reproductive potential of this species was calculated as the intrinsic rate of natural increase r = 1/D ln pN sub e, in which D is the generation time, p is the percentage of females, and N sub e is the number of eggs per female. The generation time varies between 570 days at 5 C and 101 days at 25 C and is the main factor in the determination of r. The relationship between r and temperature is nearly linear and is given by r = 0.0013 T - 0.0042. The reproductive potential of O. OXYURIS is much lower than would be predicted from body size; this, and the dominance of males in the population, is discussed in the light of the evolution of stable predator-prey systems. (Auth)

<192>
Hess, C.T., and C.W. Smith, University of Maine, Department of Physics and Astronomy and Ira C. Darling Center for Oceanography, Orono, ME

A Mathematical Model of the Accumulation of Radionuclides by Oysters (C. VIRGINICA) Aquacultured in the Effluent of a Nuclear Power Reactor to Include Major Biological Parameters.
Health Phys., 33, 121-130 (1977)

The uptake, accumulation and loss of radionuclides by the American oyster (C. VIRGINICA) acquacultured in the effluent of a nuclear power reactor has been measured monthly for three years at four field stations in the Montsweag Estuary of the Sheepscot River and at a control station in the nearby Damariscotta River Estuary, southern central coastal Maine. A mathematical model for the time variation of the specific activity of the oysters has been developed to include the physical half-lives of the various radionuclides, the biological half-lives of the various radionuclides (biological depuration), the water temperature (oyster hibernation) and shell growth. The resulting first order linear differential equation incorporating these phenomena is driven by the liquid radionuclide effluent release schedule of the Maine Yankee Nuclear Reactor. Comparison of the monthly measurements of the specific activity for Co-58, Co-60, Mn-54, Cs-134, and Cs-137 in oysters with model calculations show close agreement over all ranges of variation observed. A special feature of this mathematical model is its ability to describe the non-chemostatic field situation. (Auth)

<193>
Hesthagen, I.H., University of Oslo, Institute of Marine Biology and Limnology, Oslo, Norway

Migrations, Breeding, and Growth in POMATOSCHISTUS MINUTUS (Pallas) (Pisces, Gobiidae) in Oslofjorden, Norway.
Sarsia, 63, 17-26 (1977)

Aspects of the biology of the sand goby were studied over a period of 21 months. The goby is common in the littoral from April (at temperatures above 3 C) to July, when breeding takes place, and from September to December, when the somatic growth occurs. At temperatures above 19 C and below 4 to 5 C the goby is rare in the littoral. The growth is very rapid, the 0-group fish reaching almost the length of the 1-group fish during their first growing season. Growth is faster than in other populations from similar latitudes, suggested to be due to eutrophication. Spawning occurs even in less than 1 m depth. There is an indication that light intensity, together with temperature, is important for breeding to start. The food consists of any organism of appropriate size and texture. Polychaetes are a conspicuous component. Feeding occurs intensively all through the stay in the littoral, but is lower during the breeding season. Various features of the biology of the sand goby in Oslofjorden appear to be simple and more clearcut when compared to other populations studied, probably due to the stable and predictable environmental conditions. (Auth)

<194>
Hettler, W.F., and L.C. Clements, National Marine Fisheries Service, Southeast Fisheries Center, Beaufort Laboratory, Beaufort, NC

Effects of Acute Thermal Stress on Marine Fish

<194> CONT.
Embryos and Larvae.
In Fourth National Workshop on Entrainment and Impingement, L.D. Jensen (Ed.). EA Communications, Melville, NY, (pp. 171-190), 428 pp. (1978)

Laboratory experiments were conducted at Beaufort, North Carolina, to measure the survival of embryos and larvae of two ocean-spawning fish species exposed to rapid thermal increases. Spot (LEIOSTOMUS XANTHURUS) and black sea bass (CENTROPRISTIS STRIATA) fertilized in the laboratory were tested at specific developmental stages: pregastrula, early- and mid-embryo, and five larval ages up to 30 days old. For most tests, three acclimation temperatures, four shock temperatures, and four exposure times were employed. Besides the basic percentage survival data for each exposure time-temperature-developmental stage combination, a comparison was made of a rapid versus a slow cooling rate following exposure. Hatching times at temperatures from 15 to 27 C were found to be: ln hours= 10.47-2.28 (ln C). The pregastrula spot were more susceptible to thermal stress than later embryonic stages, whereas spot larvae showed no relationship between age and survival following thermal exposures of up to 12 C over ambient temperatures. Black sea bass had similar mortalities at both early and late embryonic stages. Slow cooling following exposure to heated water greatly increased survival of embryos compared with rapid cooling. A tentative conclusion of this study, which is still in progress, is that the majority of the population of the eggs and larvae of these two species could survive the thermal component during entrainment if the delta-T does not exceed 8 C. (Auth)

<195>
Hidu, H., and H.H. Haskin, Rutgers University, New Jersey Oyster Research Laboratory, New Brunswick, NJ

Swimming Speeds of Oyster Larvae CRASSOSTREA VIRGINICA in Different Salinities and Temperatures.
Estuaries, 1, 252-255 (1978)

Swimming speeds and behavior of oyster larvae were observed under constant and increasing salinity conditions. In addition the effect of temperature on swimming speed was noted. When subjected to hourly salinity increases of 0.5 ppt, most larvae swam upward or downward at approximately three times the speed of larvae held under constant conditions. Nondirectional swimming speeds varied considerably with temperature. The temperature effects were more notable with the earlier stage larvae, with larvae at 25 C swimming up to three times the speed of larvae at 15 C. (ST)

<196>
Hill, B.J., Rhodes University, Zoology Department, Grahamstown, South Africa

The Effect of Heated Effluent on Egg Production in the Estuarine Prawn UPOGEBIA AFRICANA (Ortmann).
Jour. Exp. Mar. Biol. Ecol. (Neth.), 29, 291-302 (1977)

Egg production of a population of UPOGEBIA AFRICANA (Ortmann) in a pond containing water heated by a thermal power station at Knysna, South Africa, was compared with that of the population in the adjacent estuary and in two other estuaries. The breeding cycle, proportions of ovigerous females, incubation time for eggs at different temperatures, number of eggs produced, sex ratios, and size-frequency of males and females were all investigated. The number of eggs produced/100 prawns was found to be nearly twice as high in the population exposed to heated effluent as compared with the population in the adjacent estuary. The increase was due to a combination of a change in sex ratio resulting in more females in the population and a greater proportion of larger females in the pond. Since the number of eggs produced/female is positively related to the size of the prawn, large females in warmer water produced more eggs than smaller females in the adjacent estuary. Exposure to heated effluent did not alter the initiation or duration of the breeding season, nor cause precocious maturity; nor did it alter the number of eggs carried per female at various sizes. (Auth)

<197>
Hines, A.H., University of California, Dept. of Zoology, Berkeley, CA

Reproduction in Three Species of Intertidal Barnacles from Central California.
Biol. Bull., 154, 262-281 (1978)

Brooding and nutrient storage cycles in populations of the three species of barnacles occurring in the warm-water discharge of the Morro Bay (Calif.) power plant discharge and in adjacent areas of ambient temperature were compared. Aspects of the regulation of these cycles by temperature, photoperiod, and food availability were investigated experimentally. The three species showed three different patterns of reproduction. TETRACLITA SQUAMOSA brooded earlier in the warm water, whereas BALANUS GLANDULA brooding was delayed there. The warm water discharge did not affect time or frequency of brooding of CHTHAMALUS FISSUS. (ST)

<198>
Hodjaev, N.N., K.A. Nikitina, and N.V. Gusev, Not given

On the Behavior of the Alga ANACYSTIS NIDULANS in the Darkness at Different Temperatures.
Moscow Univ., Vestnik. Ser. VI. Biologiia, 32, 79-83 (1977)

In darkness, cells of the alga, ANACYSTIS NIDULANS, lost their viability after 14 days at 37 C and in seven days at 45 C. At 4 C cells lived up to 3.5 months. (ST)

<199>
Holt, R.S., Jr., Texas A&M University, College Station, TX

Culture of Fish in Cages and Their Use as Biological Monitors of Water Quality within Heated Discharge Waters of a Power Station.
Ph.D. Thesis, Texas A&M University, 405 pp. (1977)

Channel catfish (ICTALURUS PUNCTATUS), sea catfish (ARIUS FELIS), Florida pompano (TRACHINOTUS CAROLINUS), sheepshead (ARCHOSARGUS PROBATOCEPHALUS), pinfish (LAGODON RHOMBOIDES), Atlantic croaker (MICROPOGON UNDULATUS), black drum (POGONIAS CROMIS), spot (LEIOSTOMUS XANTHURUS), Atlantic spadefish (CHAETODIPTERUS FABER), striped mullet (MUGIL CEPHALUS) and white mullet (MUGIL CUREMA) were cultured in floating cages between 17 July 1973 and 18 August 1975 in the intake area, discharge canal and at five stations in the cooling lake of the Houston Lighting & Power Company Cedar Bayou Generating Station near Baytown, Texas. Mixing of estuarine water drawn up Cedar Bayou by the plant with freshwater flowing down Cedar Bayou created a very

<199>
<199> CONT.

unstable environment in the plant intake canal which, after heavy rainfall, changed from brackish to freshwater within a 24 hour period. Fish survival was adversely affected. Mixing of incoming effluent with resident lake water reduced salinity fluctuations at cooling lake stations. After prolonged heavy rainfall, however, cooling lake salinities dropped and survival was adversely affected. None of the species cultured were fully suitable in situ biological monitors of intake waters. Striped mullet was the only species to survive all temperature and salinity changes in the lake but may not be sensitive enough to pollutants to be used alone. Although survival of striped mullet was high, growth rates were low. Black drum exhibited growth suitable for commercial production but died coincidental with low salinities. Channel catfish grew rapidly in water below 12 ppt salinity. Other species had low growth rates. Gas bubble disease in the discharge canal was not alleviated by increasing stocking distance from the origin of the canal. Striped mullet, sheepshead, Atlantic croaker, black drum, spot, white mullet and pinfish were stocked simultaneously in discharge canal cages. Striped mullet and sheepshead survived; all others died of gas bubble disease. Accumulation of pesticides and metals in fish tissue followed no clear patterns. Except for intake-cultured white mullet and channel catfish samples, no fish analyzed after dying in a cage had an unacceptable concentration in its tissues. (Auth) (ST)

<200>
Hoshi, T., M. Kobayashi, S. Umemura, and N. Sato,
Niigata University, Biological Institute,
Niigata, Japan

Notes on Haemoglobin and Respiration of DAPHNIA
MAGNA in Relation to Temperature and Oxygen
Content of Water and Medium.
Sci. Rep. Niigata Univ., Ser. D. (Biology) No.
15, 15-23 (1978)

The effects of water temperature and oxygen content on the respiration of pale and pink DAPHNIA was studied in large outdoor breeding tanks. The water temperature varied from a high of 26.4 C in summer to a low of 0.2 C in winter. The lowest oxygen recorded was 0.9 ml/l in summer and the largest was 13.6 ml/l in winter. The oxygen content necessary for attaining the full activity of respiration (100%) in pink DAPHNIA was smaller than that in pale DAPHNIA. This difference became larger with a rise in temperature. The natural appearance of populations of pink DAPHNIA in summer was probably associated with water conditions of little oxygen and high temperatures. (MU)

<201>
Hoss, D.E., L.C. Clements, and D.R. Colby,
National Marine Fisheries Service, Atlantic
Estuarine Fisheries Center, Beaufort, NC

Synergistic Effects of Exposure to Temperature
and Chlorine on Survival of
Young-of-the-Year Estuarine Fishes.
In Physiological Responses of Marine Biota to
Pollutants, F.J. Vernberg et al. (Eds.).
Academic Press, Inc., New York, (pp.
345-355) (1977)

The effect of chlorine exposure on young-of-the-year silverside, mojarra, and mullet acclimated at 25 to 26 C and salinity of 33 to 35 ppt and the combined effects of chlorine and thermal shock on postlarval flounder and juvenile mullet were evaluated. Each species responded differently to exposure to chlorine. Silverside appeared to be the most sensitive and exhibited a graded response with increased exposure time. Exposure to as little as 0.13 ppm chlorine for 3 min caused approximately 50% mortality. Mojarra withstood a concentration of 0.28 ppm for 7 min with no mortality. A 10 min exposure reduced survival to 25%. Survival of mullet was not appreciably reduced at any exposure time at either 0.28 or 0.50 ppm. Mullet, however, were approximately five times larger by weight than the other two species. The combined effects of chlorine and thermal shock for various exposure times (acclimation temperature 15 C, thermal shock 15 C for flounder; acclimation temperature 25 C, thermal shock 10 C for mullet), on 24 hr survival of postlarval flounder and juvenile mullet were evaluated based on response surfaces fitted to observed survival. For both species, the combined effects of chlorine and thermal shock on mortality were synergistic. Previous studies had shown that the effects of these temperature shocks alone did not cause appreciable mortality for up to 10 min exposure. (ST)

<202>
Howells, G., Central Electricity Generating
Board, Biology Section, England

In and Out of Hot Water.
Marine Poll. Bull. (G.B.), 8, 245-248 (1977)

United States and United Kingdom legislative restrictions regarding thermal discharges are reviewed. Conditions and practice in the United Kingdom are discussed for inland as well as coastal and estuarine power stations. Investigations of biological effects and problems inherent in such studies are reviewed. The author concludes that in the lack of clear evidence of damage from thermal discharges, as well as persistent doubts regarding sampling and assessing ecosystem effects, it seems premature to promote restrictive legislation or control measures, if only because appropriate methods for detecting effects are not yet available. The question is raised about justification of efforts to reduce pollutant discharge (heat) to less than no observed effect and below background levels. (ST)

<203>
Hrs-Brenko, M., C. Claus, and S. Bubic, Rudjer
Boskovic Institute, Center for Marine
Research, Rovinj, Yugoslavia; State
University of Ghent, Laboratory for
Biological Research in Environmental
Pollution, Ghent, Belgium

Synergistic Effects of Lead, Salinity and
Temperature on Embryonic Development of the
Mussel MYTILUS GALLOPROVINCIALIS.
Marine Biol., 44, 109-115 (1977)

Combined effects of lead, salinity and temperature on the embryonic development of the mussel MYTILUS GALLOPROVINCIALIS Lmk. were studied under laboratory conditions. The basic experimental design was a 4 x 6 factorial experiment using 4 lead concentrations (100, 250, 500 and 1000 ppb Pb(+2)) and 6 salinity levels (from 25 to 37.5 g/l with 2.5 g/l intervals). These factorial designs were carried out at three constant temperatures (15, 17.5 and 20 C). The statistical analysis indicated that salinity changes have more effect on the embryonic development than temperature. Optimal development was observed at 34.8 g/l and 15.6 C, which is in accordance with observations in the field. The effect of lead was minimal in optimal salinity and

<203> CONT.

temperature conditions. The deleterious effect of lead on the embryonic development was especially conspicuous at 20 C. Since in nature spawning occurs at temperatures inferior to 20 C, lead will probably not drastically decrease the potential recruitment of mussel spat in the littoral populations of the northern Adriatic Sea, where the salinity of the water is relatively stable. Under experimental conditions, lead caused a delay or inhibition of the embryonic development with the occurrence of a large number of abnormal larvae. (Auth)

<204>
Hubbs, C., and H.H. Bailey, University of Texas, Department of Zoology, Austin, TX; West Texas State University, Department of Biology, Canyon, TX

Effects of Temperature on the Termination of Breeding Season of MENIDIA AUDENS.
Southwestern Naturalist, 22, 544-547 (1977)

The Mississippi silversides, MENIDIA AUDENS, an atherinid fish inhabiting the fresh waters of the Mississippi River Valley, was used to investigate the possibility that thermal factors influenced the seasonal end of reproduction. A collection taken on July 26 of an unusually cool summer (no temperatures above 30 C in June or July) contained 15 females, 12 of which were ripe (80%). Sampling in six previous warmer summers (temperatures above 30 C occasionally in June and frequently in July) had contained no ripe females after July 15. The advantages of thermal control of the termination of a fish's breeding season are discussed. (NU)

<205>
Hunt, G.W., and A. Robertson, NUS Corporation, Pittsburgh, PA; National Oceanic and Atmospheric Administration, Ann Arbor, MI

The Effect of Temperature on Reproduction of CYCLOPS VERNALIS Fischer (Copepoda, Cyclopoida).
Crustaceana, 32, 169-177 (1977)

Some aspects of population dynamics of CYCLOPS VERNALIS were studied in the laboratory under controlled temperatures of 14, 21, 26, and 31 C. The duration of the adult stage of females varied inversely with temperature. The average longevity of the adult stage ranged from 26.2 days at 31 C to 74.2 days at 14 C. Clutch size varied from 3 to 102 eggs. The greatest mean number of eggs per clutch, 46.8 eggs, was produced at 21 C, with the clutch size at 14 C only slightly less (39.5 eggs). Least numbers of eggs per clutch, 30.2 and 31.0, were produced at 26 and 31 C, respectively. Development rate of the eggs increased linearly as temperature increased up to 26 C. From 26 to 31 C the rate of acceleration of development slowed. Hatching success ranged from 88.1% at 5 C to 96.0% at 26 C. (ST)

<206>
Illies, J., and E.C. Masteller, Max-Planck Institute of Limnology, Schlitz, German Federal Republic

A Possible Explanation of Emergence Patterns of BAETIS VERNUS Curtis (Insecta: Ephemeroptera) on the Breitenbach.
Int. Rev. Gesamten Hydrobiol. (Ger.), 62, 315-321 (1977)

BAETIS VERNUS, a major contributor to the biomass of the Breitenbach, showed a

remarkable degree of fluctuation in its emergence: in the years under observataion (1969-1975), it ranged from univoltine to trimodal patterns. It is postulated that warm overwintering temperatures produce unimodal emergence whereas cold winter temperatures (especially periods with less than 5 C) produce bimodal or trimodal emergence. The relations between egg-hatching, larval growth, and temperature are discussed. (Auth)

<207>
Imada, R., and K. Muroga, Hiroshima University, Faculty of Fisheries and Animal Husbandry, Fukuyama, Japan

PSEUDODACTYLOGYRUS MICROCHIS (Monogenea) on the Gills of Cultured Eels. I. Seasonal Changes in Abundance.
Bull. Jap. Soc. Sci. Fish, 43, 1397-1401 (1977)

Seasonal changes in the abundance of PSEUDODACTYLOGYRUS MICROCHIS in an experimental pond and in two eel farm ponds in Japan were studied. Each parasite population attained its greatest abundance in August-October, following a period of high water temperature (26-30 C). (ST)

<208>
Jacques, T.G., University of Rhode Island, Kingston, RI

Metabolism and Calcification of the Temperate Scleractinian Coral ASTRANGIA DANAE.
Ph.D. Thesis, University of Rhode Island, 187 pp. (1978)

ASTRANGIA DANAE, the only shallow-water stony coral of the temperate West Atlantic, was acclimated to various temperatures to examine how zooxanthellae affect gas exchanges and coral calcification, and to evaluate the effect of temperature and light intensity on these processes. In non-fed colonies at 27 C, polyp respiration averaged 18 umol O2/dm2/h. Maximum calcification was 24 umol CaCO3/dm2/h. Calcification rates were less at lower temperatures; the regression equation suggested net CaCO3 losses below 16 C. In fed colonies, the mean polyp respiration reached 60 umol O2/dm2/h at 27 C. Fed colonies fixed up to 60 umol Ca CO3/dm2/h at 27 C and calcified measurably down to 11.5 C. Calcium intake increased linearly with temperature in non-symbiotic colonies, and in symbiotic colonies tested in darkness. Only above 15 C did A. DANAE derive a calcification benefit from its association with zooxanthellae. (NU)

<209>
Janos, S., H-8237 Tihany Biologia, Hungary

Effect of Environmental Factors on the Endogenous Rhythm of the Fresh Water Mussel (ANODONTA CYGNEA L.).
Annl. Biol. Tihany (Hung.), 44, 123-136 (1977)

The effect of oxygen, changes in temperature, heavy metals, pesticides, and other environmental factors on the daily rhythm of the freshwater mussel ANODONTA CYGNEA L. was investigated. A decrease in water temperature from 20 to 11 C caused a decrease in total activity per day from 18 to 11 hours. Labortory experiments showed that rapid changes in water temperature, either cooling or warming, caused a transient increase in the frequency of rhythmic activity. In the case of gradual changes in temperature, cooling led to a decrease in the frequency of the rhythmic movements of the shells, while warming caused an increase in it. Duration of the

<209>
<209> CONT.

activity periods became prolonged when the water was cooled from 20 to 5 C within 24 hours. Increase in the temperature with the same value and rate decreased the duration of the active periods. At temperatures of 2 to 4 C the animals were mainly closed. (MU)

<210>
Jensen, K., Marine Biological Laboratory,
Helsingor, Denmark

Optimal Salinity and Temperature Intervals of LIMAPONTIA CAPITATA (Opistobranchia, Sacoglossa) Determined by Growth and Heart Rate Measurements.
Ophelia, 16, 175-185 (1977)

Growth rate of LIMAPONTIA CAPITATA was determined at various temperatures (5 to 20 C) and salinities. An optimal temperature of about 15 C was found on the basis of growth rate, percentage of nongrowing animals during the experiments, spawning, and heart rate measurments. Q10 of heart rates shows a high value in the temperature interval immediately preceeding maximum heart rate. This indicates a marked increase in respiration without a corresponding increase in growth. Heat coma set in at 38-40 C, and cold comma is estimated to set in around 0 C. In late summer and early autumn, when the experimental animals were collected, the estimated mean water temperature in the sampling area was about 15 C. Based on the same factors as above (no heart rate measurements), an optimal salinity of about 30 ppt was determined. This is far from the mean of the sampling area (about 15 ppt), and spawning is as abundant (or more so) at 20 and 15 ppt, so adaption to salinity - although not with respect to growth - seems to exist. Death of osmotic stress only occurred at room temperature (20-23 C) and a concurrent salinity of 5 ppt. (Auth)

<211>
Jensen, L.D. (Ed.), Ecological Analysts, Inc.,
Melville, NY

Fourth National Workshop on Entrainment and Impingement.
EA Communications, Melville, NY (1978)

The publication represents a compilation of regulatory and technical information on impingement and entrainment. Separate sections of the workshop were devoted to regulatory issues, entrainment abundance and survival, impingement studies, impact assessment techniques, and engineering aspects of entrainment and impingement. Thirteen papers on thermal tolerance, the effects of environmental variables on fish impingement, and the effects of thermal stress on entrained organisms were selected and abstracted separately for the data base. (ST)

<212>
Jinks, S.M., T.C. Cannon, D. Latimer, L. Claflin, and G.J. Lauer, Ecological Analysts, Inc.,
Middletown, NY

An Approach for the Analysis of Striped Bass Entrainment Survival at Hudson River Power Plants.
In Fourth National Workshop on Entrainment and Impingement, L.D. Jensen (Ed.). EA Communications, Melville, NY, (pp. 343-356), 424 pp. (1978)

Predictive assessments of the survival of organisms entrained through open-cycle cooling systems of power plants are discussed. An approach is suggested that integrates information from field studies and laboratory thermal tolerance experiments with the plant operating conditions determining organism exposure during entrainment. Data on Hudson River striped bass are presented to illustrate the use of this approach to predict the time-varying probability of survival from entrainment and the temporal distribution of cropping. The predictive assessments provide insights into the important natural and plant operating conditions controlling the magnitude of entrainment effect. (Auth)

<213>
Johns, D.M., and W.H. Lang, USEPA, Environmental Research Laboratory, Narragansett, RI;
Belle W. Baruch Institute for Marine Biology and Coastal Research, University of South Carolina, Columbia, SC

Larval Development of the Spider Crab, LIBINIA EMARGINATA (Majidae).
Fishery Bull., 75, 831-841 (1977)

Larval development of the spider crab, LIBINIA EMARGINATA, consists of two zoeal stages and megalopa. Laboratory-reared larvae (South Carolina and Rhode Island) are described and compared with planktonic larvae from Narragansett Bay, R.I. No significant varations in morphology were found between laboratory- cultured larvae and "wild" larvae from plankton catches; first stage zoea from South Carolina were smaller than Rhode Island specimens. Using ARTEMIA diets, the best percentage survival in culture was found to be 20 C for Rhode Island larvae and 25 C for South Carolina larvae. Zoeal stages show little difference from larvae of L. DUBIA; however, the megalopae of the two species can be differentiated by the number of protuberances on the cardiac region of the carapace. (Auth)

<214>
Johnson, M.F., LGL Limited, Environmental
Research Associates, Bryan, TX

Studies on the Reproductive Cycles of the Calcareous Sponges CLATHRINA CORIACEA and C. BLANCA.
Marine Biol. (W. Ger.), 50, 73-79 (1978)

The reproductive cycles of two closely related calcareous sponges, CLATHRINA CORIACEA and C. BLANCA, were studied to determine whether they were reproductively isolated. Populations of both species were sampled at Santa Catalina Island, California, for 2.5 years. The reproductive period is from July to October in C. CORIACEA, and from April to August in C. BLANCA. Seawater temperature and habitat influence reproduction in both species. C. CORIACEA required a temperature of 18.5 C for initiation of oogenesis; C. BLANCA required a minimum temperature of 14.5 C. In C. CORIACEA, the maximum number of specimens with reproductive elements was found in the middle of August when the seawater temperature was 20 C. In C. BLANCA, however, the maximum percent of breeding individuals was seen in the third to fourth week in May when the temperature reached 17 C. Fragmentation occurred in C. CORIACEA in the summer, while asexual reproduction by means of budding was seen in C. BLANCA throughout the year. The results of the study confirm that the two sponges are separate species. (Auth) (ST)

<215>
Jokiel, P.L., and H.B. Guinther, Hawaii Institute
of Marine Biology, Kaneohe, HI

<215> CONT.
Effects of Temperature on Reproduction in the Hermatypic Coral POCILLOPORA DAMICORNIS.
Bull. Marine Sci., 28, 786-789 (1978)

The optimal reproductive temperature for the coral POCILLOPORA DAMICORNIS (L.) in Hawaii compares with the 26-27 C optimum previously reported for skeletal growth. The reproductive peak is approximately ten times stronger than the observed growth response for the species. Temperature appears to influence abundance of this species primarily through control of the reproductive process. (Auth)

<216>
Jonas, R.B., E.W. Buckley, and F.K. Pfaender, University of North Carolina, Department of Environmental Sciences and Engineering, Chapel Hill, NC

A Note on the Isolation of the Bacterium VIBRIO PARAHAEMOLYTICUS from Estuarine North Carolina.
Estuaries, 1, 264-266 (1978)

The potentially pathogenic bacterium, VIBRIO PARAHAEMOLYTICUS, was isolated from water, sediment, and oyster samples collected from estuarine North Carolina. In October, when water temperatures were 15 to 18 C, V. PARAHAEMOLYTICUS was still detected in all substrates. However, the organism was detected only in one sediment sample in January when water temperatures were 4 to 5 C. No correlation was observed between the occurrence of the bacterium and domestic wastewater contamination. (Auth)

<217>
Jones, R., Marine Laboratory, Aberdeen, Scotland

Estimates of the Food Consumption of Haddock (MELANOGRAMMUS AEGLEFINUS) and Cod (GADUS MORHUA).
Jour. Cons. Intl. Explor. Mer (Den.), 38, 18-27 (1978)

Estimates were made of the annual food consumption of North Sea and Faroe haddock and cod of various sizes. Two methods of computation were used. One was based on estimates of the energy required for maintenance, growth and reproduction, the other was based on mean stomach content weights. Both methods took into consideration the effect of temperature. It was concluded that for both haddock and cod, energy intake can be treated as proportional to body weight to a given power, and cod required more energy for growth and maintenance than haddock. (ST)

<218>
Jones, R.I., University of Ulster, Limnology Laboratory, Traad Point, Magherafelt, Co. Londonderry, Northern Ireland

The Importance of Temperature Conditioning to the Respiration of Natural Phytoplankton Communities.
Brit. Phycol. Jour., 12, 277-285 (1977)

For natural phytoplankton communities from Kinnego Bay, Lough Neagh (Northern Ireland), the respiration rate at each of five laboratory temperatures (5, 9, 13, 17, and 21 C) was not constant through a season but showed changes which could be related to the lake temperature at the time of sampling. This effect was more marked when respiration rates were expressed per unit of chlorophyll a rather than per unit of algal volume. This provided one explanation for some improbably high respiratory Q10 values that have been reported from field studies. <215>
Other factors besides temperature may have been involved in producing the observed effect. (Auth)(MU)

<219>
Kabay, E.E., and J.J. Gilbert, Universite Nationale du Rwanda, Butare, Rwanda; Dartmouth College, Department of Biological Sciences, Hanover, NH

Polymorphism in the Rotifer ASPLANCHNA SIEBOLDI: Insensitivity of the Body-Wall-Outgrowth Response to Temperature, Food Density, pH and Osmolarity Differences.
Arch. Hydrobiol. (Ger.), 83, 377-390 (1978)

Experiments were performed to test the effects of a temperature difference of 10 C (18 to 28 C), food density, pH, and osmolarity on the sensitivity of the freshwater rotifer ASPLANCHNA SIEBOLDI to tocopherol. The temperature difference had only minor effects on the pattern of response to tocopherol. Body shape was also insensitive to the other factors studied. (ST)

<220>
Kaeding, L.R., and C.M. Kaya, Montana State University, Department of Biology, Bozeman, MT

Growth and Diets of Trout from Contrasting Environments in a Geothermally Heated Stream: The Firehole River of Yellowstone National Park.
Trans. Amer. Fish. Soc., 107, 432-438 (1978)

Differences in seasonal patterns of growth, length at age, and diet were evident between brown trout (SALMO TRUTTA) residing in geothermally heated and unheated sections of the Firehole River. Maximum temperatures at the warmest station exceeded 28 C and averaged about 10.5 C higher than the unheated station throughout the year. Scale characteristics indicated that brown trout from the heated stations had two annual growth periods while those from the unheated station had one, relatively short, annual growth period. Brown trout from the heated stations were significantly longer at any particular age than those from the unheated station. Caddisflies were the numerically dominant food in the unheated water while trout at the heated station fed most extensively on dipterans, molluscs, and mayflies. Additionally, trout in the unheated water fed almost entirely on immature benthic insects while those at the heated station fed heavily on emerging insects and exhibited considerably greater numbers of organisms per stomach. Rainbow trout (SALMO GAIRDNERI), numerous only at the heated station, had seasonal growth pattern, length at age, and diet similar to those of brown trout at this station. (Auth)

<221>
Kajak, Z., Institute of Ecology, Department of Hydrobiology, Lomianki, Poland

Effect of Heated Waters on Biocenosis of the Moderately Polluted Narew River. General Conclusions.
Pol. Arch. Hydrobiol., 23, 555-561 (1976)

The cumulative effect of organic pollution and thermal effluent from a power station on the Narew River (Poland) resulted in an increase in biomass of phytoplankton, an increase in the number of actinomycetes and COLI organisms, a decline in the number of benthic chironomids, an increased fluctuation of tubificids, and increased destructive processes. Biomass of blue-green algae increased while diatom

<221>
<221> CONT.

biomass declined. The effect of heating alone (2 C) resulted in a drop in the number of benthic chironomid species, an increase in the number of sexually mature tubificids, and a slight increase in number of mesosaprobic species of periphyton. (ST)

<222>
Kampa, D.M., University of Tennessee, Department of Zoology, Knoxville, TN

The Effect of Temperature on the Development Time and Brood Size of DIAPTOMUS PALLIDUS Herrick.
Hydrobiologia (Den.) 61, 75-80 (1978)

DIAPTOMUS PALLIDUS individuals were raised in the laboratory at three temperatures (15, 20, and 25 C) and fed an alfalfa and trout-food diet ad libitum. Data were taken on the development times of the egg, naupliar, and each copepodid stage and the brood sizes of field animals acclimated to the test conditions. The results indicated D. PALLIDUS does not have a temperature range over which its development rate is nearly constant as earlier reported. Rather, the development rate is temperature dependent within the experimental range. Broods produced at 20 C and 25 C were significantly smaller than those produced at 15 C but not significantly different from each other. (Auth)

<223>
Kanciruk, P., and W. Herrnkind, Florida State University, Department of Biological Science, Tallahassee, FL

Mass Migration of Spiny Lobster, PANULIRUS ARGUS (Crustacea: Palinuridae): Behavior and Environmental Correlates.
Bull. Marine Science, 28, 601-623 (1978)

Field and laboratory studies of the autumnal mass migration of the spiny lobster, PANULIRUS ARGUS, were conducted during the autumns of 1969 and 1971-74 at Bimini, Bahamas. Autumnal storms, with resultant declines in water temperatures, occurred predictably in the migratory period, and were associated with the mass migration over a period of 10 years. Laboratory and semi-field studies substantiated the hypothesis that a sharp drop in temperature serves as the environmental trigger for the mass migration. Actographs and time-lapse photographic records of lobster groups showed that all three major characteristics of the mass migration (hyperactivity extending into daylight, continuous queuing, and oriented locomotion) occurred in laboratory pools in association with temperatures declines. (ST)

<224>
Kangas, P., and G. Skoog, University of Oulu, Department of Zoology and Bothnian Bay Research Station, Oulu, Finland; University of Stockholm, Department of Zoology and Asko Laboratory, Stockholm, Sweden

Salinity Tolerance of THEODOXUS FLUVIATILIS (Mollusca, Gastropoda) from Freshwater and from Different Salinity Regimes in the Baltic Sea.
Estuarine & Coastal Marine Sci., 6, 409-416 (1978)

The salinity tolerance of adult THEODOXUS FLUVIATILIS was investigated on populations from freshwater and from three different salinity regimes in the Baltic Sea. The snails were taken from the salinity of their original habitats, and the transition to the experimental salinities was made gradually over a period of a few days. Under these conditions differences in tolerance between populations were found: a common range of high tolerance was found in all populations in salinities 1.5-10 g/l, while in higher (15-20 g/l) and lower (1.0-0 g/l) salinities, differences between populations seemed to be correlated to their origin. Populations from freshwater and low salinity showed a higher tolerance to the lowest salinities, while populations from higher salinities were more tolerant of the highest salinities tested. The freshwater animals showed, however, a somewhat higher tolerance in high salinities than might be expected from their origin. The tolerance at 5 C was generally higher than at 15 C. (Auth)

<225>
Kapraun, D.F., University of North Carolina, Department of Biology, Wilmington, NC

Asexual Propagules in the Life History of POLYSIPHONIA FERULACEA (Rhodophyta, Ceramiales).
Phycologia, 16, 417-426 (1977)

The life history of POLYSIPHONIA FERULACEA Surh from North Carolina was found to include specialized asexual reproductive propagules, developmentally and morphologically resembling spermatangial branches but appearing on male, female, and tetrasporophytic plants and recycling the particular phase that produced them. Light intensity and temperature effects on growth, sexual reproduction, and propagule formation were studied with a cross-gradient light-temperature apparatus which permitted the simultaneous culture of 25 combinations of the two parameters. Light intensity ranged from 430 to 2580 lux and temperature from 10 to 30 C. Both gametophytic and tetrasporophytic phases of P. FERULACEA developed best at 25 C and 2040 to 2570 lux illumination. Conditions favoring vegetative growth and sexual reproduction also initiated propagule formation. There was no indication that antheridial propagules were induced by stresses in the environment but rather formed in response to a broad range of light-temperature parameters as were typical gametangia and sporangia. (MU)

<226>
Kapraun, D.F., University of North Carolina, Department of Biology, Wilmington, NC

Field and Cultural Studies on Selected North Carolina POLYSIPHONIA Species.
Botanica Marina, 21, 143-153 (1978)

POLYSIPHONIA URCEOLATA, P. FERULACEA, and P. DENUDATA, representing species of cool temperate, tropical, and warm temperate affinities, respectively, were investigated in cross-gradient light-temperature culture to determine the effects of light intensity (430 to 2580 lx) and temperature (10 to 30 C) on growth and reproduction. Both gametophytic and tetrasporophytic phases of P. FERULACEA and P. URCEOLATA developed best between 15 to 25 C and 963 to 2568 lx. Some growth occurred for these species in all combinations of light and temperature excepting P. URCEOLATA gametophytic growth which was inhibited at the highest temperatures (30 C). Best reproductive development for P. DENUDATA occurred between 15 to 25 C and 642 to 2568 lx. Tetrasporangial development seemed to be enhanced in the higher temperature regimes (25 to 30 C). Antheridial development seemed to be inhibited in combinations of high light intensity (2580 lx) and extreme high (30 C) or low (10 C) temperatures. (MU)

<227>
Kasahara, S., and T. Akiyama, Hiroshima University, Faculty of Fisheries and Animal Husbandry, Fukuyama, Japan

Notes on the Dormancy in the Adults of TIGRIOPUS JAPONICUS.
Jour. Fac. Fish. Animal Husb., Hiroshima Univ. (Jap.), 15, 57-65 (1976)

Low temperatures induced temporary dormancy in the harpacticoid copepod TIGRIOPUS JAPONICUS. Animals cultured at 15 to 20 C were active above 4 C. Below 2 C they lost their locomotive power and sank to the bottom of the culture vials. Animals made dormant by temperatures as low as -2 C could be revived. Animals cultured at 25 C became dormant below 8 C. (ST)

<228>
Kersting, K., Research Institute for Nature Management, Leersum, The Netherlands

Some Features of Feeding, Respiration and Energy Conversion of DAPHNIA MAGNA.
Hydrobiologia (Den.), 59, 113-120 (1978)

Results of studies of the energy budget of DAPHNIA MAGNA are presented. Filtering and feeding rates, studied over the temperature range 10 to 26 C, were highest above 22 C. Growth efficiency was maximal at 10 C and negative above 22 C. (ST)

<229>
Kimball, M.C., Miami University, Coral Gables, FL

Effect of Thermal Effluent on Nitrogen Fixation in the Sediments of Guayanilla Bay, Puerto Rico.
Ph.D. Thesis, Miami University, Coral Gables, 112 pp. (1977)

Nitrogen fixation by sediment microflora was studied from March 1976 through January 1977 in Guayanilla Bay on the south coast of Puerto Rico. The study was located in an area which receives thermal effluent from a power plant. The temperature annually ranged from 25 to 30 C in the control areas and from 30 to 40 C in the discharge area. Rates of nitrogen fixation were measured in situ with the acetylene reduction technique. High rates of nitrogen fixation generally corresponded with the development of blue-green algal mats. A blue-green algal mat, predominantly composed of MICROCOLEUS VAGINATUS formed in the discharge area when temperatures were at or above 35 C. Despite high rates of fixation by light incubated samples, dark heterotrophic processes (bacteria) appeared to account for the majority of nitrogen fixed in the blue-green algal mat during a 24 hour period. (Auth)(MU)

<230>
King, D.P.F, M.J. O'Toole, and A.A. Robertson, Sea Fisheries Branch, Sea Point, Capetown, South Africa

Early Development of the South African Maasbanker TRACHURUS TRACHURUS at Controlled Temperatures.
Fish. Bull. S. Africa, 9, 16-22 (1977)

Egg and larval developmental rates of the horse mackerel were studied at ten constant temperatures, ranging from 12.6 to 24.3 C. During embryonic development the incubation time to any given developmental stage decreased exponentially with increasing temperature. At the lowest and highest incubation temperatures, 12.6 and 24.3 C, complete gastrulation required 36 hr and 2 hr, respectively, and the period to hatching, 84 hr and 20 hr, respectively. The time of development from hatching to absorption of the yolk in the larvae ranged from 5.5 days at 12.6 C to 1 day at 24.3 C. Maximum growth rate of larvae was observed at the highest temperature. (ST)

<231>
King, R.G., NALCO Environmental Sciences, Lincoln, NB

Entrainment of Missouri River Fish Larvae through Fort Calhoun Station.
In Fourth National Workshop on Entrainment and Impingement, L.D. Jensen (Ed.). EA Communications, Melville, NY, (pp. 45-56), 424 pp. (1978)

The effects of condenser passage and plume entrainment of larval fishes in the Missouri River were studied at Fort Calhoun Station from 1974 through 1977. The study determined the viability of entrained fish larvae through live-dead separations of samples collected from intake, discharge, and plume locations. In addition, the horizontal and vertical distributions of larvae were determined to estimate the impact of station operation. This estimate was based on the percentage of river flow diverted for cooling water, the differential mortality (discharge minus intake mortality), and the percentage of larvae passing the station that were entrained. Fish larvae generally appeared in the drift in early May and reached peak densities from mid-June through mid-July. The predominant larvae included freshwater drum, catostomids, carp, and STIZOSTEDION spp. Condenser passage mortality was attributed to combined mechanical and thermal effects. Plume entrainment generally did not result in decreased larval viability. High river velocity and low larval densities caused sampling problems, which made it difficult to determine entrainment effects. Net size, type of collection bucket, sampling duration, and drift velocity were varied during the study in an attempt to reduce collection-induced mortality. Condenser passage effects were consistently demonstrated when intake samples were collected at drift velocities similar to discharge velocities. (Auth)

<232>
Knowles, S.C., and R.G. Zingmark, University of South Carolina, Department of Biology and Belle W. Baruch Institute for Marine Biology and Coastal Research, Columbia, SC

Mercury and Temperature Interactions on the Growth Rates of Three Species of Freshwater Phytoplankton.
Jour. Phycol., 14, 104-109 (1978)

Cultures of freshwater algae, representing three algal divisions, SYNURA PETERSENII Korshikov; CHLAMYDOMONAS sp.; and NITZSCHIA sp., were subjected to four different mercury-temperature shock interactions to demonstrate synergistic effects between mercury and temperature. Algal growth, measured by temporal changes in in vivo fluroescence of chlorophyll was used to ascertain the effects. Mercury addition and temperature shock had various inhibitory effects on algal growth. Prior environmental conditions influenced the effect of subsequent treatments. Growth of S. PETERSENII was severely inhibited by mercury in all experiments. Control cultures would not grow at 30 C and died when shocked at this temperature. CHLAMYDOMONAS sp. cultures initially inhibited by mercury were able to recover under most conditions after a period of reduced growth. NITZSCHIA sp. was resistant

<232> CONT.

to mercury except when simultaneously shocked with temperature. Mercury analyses showed that NITZSCHIA cells at 25 C and 30 C contained a high percentage of the mercury initially added to the cultures. There was a significant loss of mercury at the end of each experiment from all cultures, probably due to volatilization. (AUTH)

<233>
Koo, T.S.Y., and M.L. Johnston, Chesapeake Biological Laboratory, Center for Environmental and Estuarine Studies, University of Maryland, Solomons, MD

Larval Deformity in Striped Bass, MORONE SAXATILIS (Walbaum), and Blueback Herring, ALOSA AESTIVALIS (Mitchill), due to Heat Shock Treatment of Developing Eggs.
Environ. Poll., 16, 137-149 (1978)

Fertilized eggs of striped bass and blueback herring were subjected to time-temperature exposures typically experienced by entrained organisms in a power plant cooling system. Egg mortality and hatchability were not necessarily good criteria in assessing temperature effects for, even when there was no significant difference in mortality and hatchability between experimental and control lots, adverse effects were manifested in the deformity of larvae hatched. Deformities took the form of shortened body, enlarged finfold and curved or twisted spine. The severity and incidence of deformity were related to temperature dose, i.e. the product of the elevated temperature and exposure time. No immediate heavier mortality was observed in deformed larvae than in normal larvae, but the lack of normal swimming ability of the deformed larvae suggests their poor eventual survivability. (Auth)

<234>
Kornobis, S., Agricultural Academy, Institute of Applied Zoology, Poznan, Poland

Ecology of DREISSENA POLYMORPHA (Pall.) (Dreissenidae, Bivalvia) in Lakes Receiving Heated Water Discharges.
Pol. Arch. Hydrobiol., 24, 531-545 (1977)

Investigations on the ecology of DREISSENA POLYMORHA inhabiting the heated lakes of the Konin district in Poland were carried out from 1973-75. Compared to non-heated lakes, DREISSENA occurred at shallower depths and in lower densities in the heated lakes. The planktonic larval stage was prolonged in the heated lakes, but the life span of settled organisms was shorter. (ST)

<235>
Kowalski, K.T., J.P. Schubauer, C.L. Scott, and J.R. Spotila, State University College at Buffalo, Department of Biology, Buffalo, NY

Interspecific and Seasonal Differences in the Temperature Tolerance of Stream Fish.
Jour. Thermal Biol., 3, 105-108 (1978)

Interspecific differences are reported in the temperature tolerance (CTM) of 13 species of stream fish acclimated to 15.0 C with a photperiod of LD 12:12. NOTROPIS STRAMINEUS had the highest CTM (33.1 C) while HYPENTELIUM NIGRICANS (30.8 C), COTTUS BAIRDI (30.9 C), AND NOCOMIS MICROPOGON (30.9 C) had the lowest CTM's. NOTROPIS STRAMINEUS, N. CORNUTUS, and ETHEOSTOMA NIGRUM acclimated for four weeks to constant laboratory conditions had statistically significant seasonal differences in their CTM's. (Auth)

<236>
Kremer, P., University of Rhode Island, Graduate School of Oceanography, Kingston, RI

Respiration and Excretion by the Ctenophore MNEMIOPSIS LEIDYI.
Marine Biol. (W. Ger.), 44, 43-50 (1977)

Respiration and excretion rates were measured for a variety of sizes of MNEMIOPSIS LEIDYI over a temperature range of 10.3 to 24.5 C. Both respiration and excretion rates were a direct linear function of animal weight and very temperature sensitive. Oxygen uptake ranged from 155 O_2/g dry weight/day at 16 C to 489 at 24.5 C (Q_{10} = 3.67). The release of carbon dioxide, ammonium, and reactive phosphorus showed a similar pattern with temperature to that described for oxygen. (ST)

<237>
Kruger, R.L., and R.W. Brocksen, University of California, Department of Animal Physiology and Institute of Ecology, Davis, CA

Respiratory Metabolism of Striped Bass, MORONE SAXATILIS (Walbaum), in Relation to Temperature.
Jour. Exp. Mar. Biol. Ecol. (Neth.), 31, 55-66 (1978)

The oxygen consumption of striped bass (MORONE SAXATILIS) was determined using tunnel-type flowing water respirometers. Standard metabolic rates were established and active metabolic rates were determined at water velocities of 1.0, 5.0, and 10.0 cm/sec and at temperatures of 8, 12, 16, 20, and 24 C. Using the difference between the standard and active metabolic rates at 10.0 cm/sec swimming velocity, a measure of the scope for activity over a limited range of velocities was derived. The scope for activity was similar at water temperatures of 8, 12, and 16 C, being 55, 44, and 45 mg O_2/kg/hr, respectively for a representative 40 g striped bass. At 20 and 24 C, the scope for activity was 99 and 143 mg O_2/kg/hr, respectively. In terms of the potential for energy expenditure, the highest scope for activity was at 24 C and the lowest at 12 C. Extrapolations to higher swimming velocities were made from the literature. Under the experimental conditions, the observations on the energetic expenditure for swimming activity by juvenile bass indicated that the temperature optimum for swimming is 16 C. (Auth) (ST)

<238>
Kulkarni, G.K., and R. Nagabhushanam, Marathwada University, Department of Zoology, Aurangabad, India

Thermal Acclimation Induced Compensation in Biochemical Constituents of the Indian Freshwater Leech, POECILOBDELLA VIRIDIS (Blanchard).
Hydrobiologia (Den.), 58, 3-6 (1978)

POECILOBDELLA VIRIDIS was used to study the variations in the biochemical parameters: body protein, glycogen and water, following warm (32.0 plus or minus 0.5 C) and cold (10.0 plus or minus 0.5 C) acclimation for 5, 10, 15 and 30 days. The percentage of glycogen decreased significantly ($p<0.05$) during both warm and cold acclimation whereas the protein percentage increased significantly ($p<0.05$). The percentage of water was significantly ($p<0.05$) reduced during both acclimation processes. Ecophysiological significance of these alterations to leeches, in counteracting the

<238> CONT.
ambient thermal fluxes, has been briefly discussed. (Auth)

<239>
Kulkarni, K.M., Institute of Science, Department of Zoology, Bombay, India

Effect of Temperature and Salinity on Heat Tolerance of EMERITA HOLTHUISI.
Geobios, 5, 97-100 (1978)

Effects of acclimation and salinity on temperature tolerance of the sand crab, EMERITA HOLTHUISI, were studied. Without acclimation (crabs held for 24 h at 30 C and 32 ppt salinity) the 50% survival value was 34.3 C. The 50% survival value for crabs acclimated for at least one week at 30 C and 32 ppt salinity was 36.1 C. Both high acclimation temperatures and high salinities contributed to heat resistance. (ST)

<240>
Kuperman, B.I., and R.E. Shulman, Leningradkii Gosuartvanyi Universitet, USSR

The Influence of Some Abiotic Factors on the Development of ERGASILUS SIEBOLDI (Crustacea, Copepoda).
Parazitologiia (USSR), 11, 117-122 (1977)

Conducted experiments and observations in nature have shown that in spring and early summer the formation of egg sacs of ERGASILUS SIEBOLDI is stimulated only by temperature while from midsummer and in autumn it depends to a considerable extent on day length. This suggests that parasitic crustaceans of the genus ERGASILUS have a state of diapause. (Auth)

<241>
Kwain, W., and R.W. McCauley, Ontario Ministry of Natural Resources, Fish and Wildlife Research Branch, Sault Ste. Marie, Ontario, Canada; Wilfrid Laurier University, Department of Biology, Waterloo, Ontario, Canada

Effects of Age and Overhead Illumination on Temperatures Preferred by Underyearling Rainbow Trout, SALMO GAIRDNERI, in a Vertical Temperature Gradient.
Jour. Fish. Res. Bd. Can., 35, 1430-1433 (1978)

During their first 12 months of life rainbow trout, SALMO GAIRDNERI, preferred progressively cooler temperatures as they grew older; 19 C was selected during the first month and the selected temperature declined by intervals of 0.5 C for each of the following months up to the third month. Fish swam higher in temperature gradients exposed to overhead illumination than in those in total darkness. This trend was reversed during the following nine months. These findings demonstrate the important role that age plays in the temperature preference of this species and the influence that overhead light may have on the distribution of fish in vertical gradients. (Auth)

<242>
Lacoursiere, E., G. Vaillancourt, and R. Couture, University of Quebec at Three Rivers, Department of Chemistry-Biology, Three Rivers, Quebec, Canada

Relation between Aquatic Plants and Gastropods (Mollusca, Gastropoda) in the Region of the Gentilly I Nuclear Reactor (Quebec).
Can. Jour. Zool. 53, 1868-1874 (1975)

This study is based on a sampling of the gastropods present in the vegetation of the St. Lawrence riverside zone at Gentilly. A total of 536 plant specimens belonging to 20 species as well as 37,239 specimens grouping 10 different species of gastropods were sampled. A comparison of the plant species - mollusc data was carried out. The analysis of the results indicates that prosobranchs have no affinity whatsoever for any plant species in particular. The pulmonates, however, are found mainly on emergent plants. (Auth)

<243>
Lakshmi, G.J., A. Venkataramiah, and H.D. Howse, Gulf Coast Research Laboratory, Ocean Springs, MS

Effect of Salinity and Temperature Changes in Spontaneous Muscle Necrosis in PENALEUS AZTECUS Ives.
Aquaculture, 13, 35-43 (1978)

Spontaneous muscle necrosis was studied in brown shrimp in relation to salinity and temperature changes. In shrimp acclimated and tested at 26 C, the incidence of necrosis was lower and the recovery rate higher than those acclimated at 21 or 31 C. Shrimp acclimated at 31 C had the highest incidence and lowest recovery rate of all those tested (8.4 and 17.4%). Necrosis also appeared faster. (ST)

<244>
Landgraf, J.C., and M.J. Starzyk, Northern Illinois University, Department of Biological Sciences, Dekalb, II

The Blue-Green Algae in Nuclear Power Plant Cooling Water.
Microbios, 18, 151-157 (1977)

A study was undertaken to determine the effects of passage through the cooling system of the Zion Nuclear Plant, Illinois, on the blue-green algae present in lake water. The blue-green algae were isolated by means of membrane filtration, enumerated and identified to genera. As a result of cooling system passage there was a definite reduction in the numbers of blue-green algae. This reduction appeared to be due to mechanical, as well as elevated temperature, damage. A few genera showed only a slight change in number. (Auth)

<245>
Langford, T.E., Marine Biological Laboratory, Fawley Power Station, Fawley, Hants, UK

Biological Problems with the Use of Sea Water for Cooling.
Chemistry and Industry, 16, 612-616 (1977)

Some of the biological problems associated with the use of seawater for cooling are discussed. Impingement and screen blockages and culvert and condenser fouling are identified as important problems. Biocides and antifouling methods and their resultant ecological effects are briefly reviewed. (ST)

<246>
Langford, T.E., and G. Howells, Marine Biology Laboratory, Fawley Power Station, Hampshire, UK; Central Electricity Research Laboratories, Leatherhead, Surrey, UK

The Use of Biological Monitoring in the Fresh-Water Environment by the Electrical Industry in the UK.
In "Biological Monitoring of Inland Fisheries" J.S. Alabaster (Ed.), Appl. Sci. Publ. London, FAO Paper. Academic Press, London

<246>
<246> CONT.
(1977)

A 15-year program of biological monitoring and supporting laboratory and model studies to assess the effects of heated discharges on British rivers were critically reviewed. Presently used monitoring techniques of qualitative or quantitative sampling of macroinvertebrates or fish communities to calculate a diversity or biotic index do not yield the evidence of significant biological changes shown by detailed and long-term observations of life history, growth, seasonal movements, and distribution. Studies on the Rivers Trent and Severn, both of which receive thermal discharges, were reviewed. (ST)

<247>
Larrick, S.R., D.S. Cherry, K.L. Dickson, and J. Cairns, Jr., Virginia Polytechnic Institute and State University, Blacksburg, VA

The Use of Various Avoidance Indices to Evaluate the Behavioral Response of the Golden Shiner to Components of Total Residual Chlorine.
Conf-771070; In Water Chlorination: Environmental Impact and Health Effects, Volume 2, R.L. Jolley et al. (Eds.), Proceedings of the Second Conference on the Environmental Impact of Water Chlorination, Gatlinburg, TN, October 31-November 4, 1977. Ann Arbor Science, Ann Arbor, MI (pp. 135-147), 909 pp. (1977; 1978)

Chlorine avoidance behavior of golden shiners (NOTEMIGONUS CRYSOLEUCAS) was analyzed for four acclimation temperatures; 12, 18, 24 and 30 C. The avoidance trough used in the experiments had water flowing in either end and draining at the center. Residual oxidant levels were measured by amperometric titration and HOCL values were calculated from water temperature and pH conditions. Avoidance thresholds, calculated from residence times (when significantly (0.05) less time was spent in the treated water than during control periods) were correlated with HOCL concentration and not with free, combined or total residual chlorine values. The HOCL thresholds (0.015 to 0.017 mg/l as determined by the Kruskal-Wallis Multiple Comparison Test) did not vary with acclimation temperature. The authors concluded that the effect of water temperature on the HOCL dissociation constant may influence fish behavior more than its direct effect on the rate of the chemical reactions within the fish which induce avoidance responses. (DMO)

<248>
Larson, G.L., and D.A. Schlesinger, Oregon State University, Oak Creek Laboratory of Biology, Department of Fisheries and Wildlife, Corvallis, OR

Toward an Understanding of the Toxicity of Intermittent Exposures of Total Residual Chlorine to Freshwater Fishes.
Conf-771070; In Water Chlorination: Environmental Impact and Health Effects, Volume 2, R.L. Jolley et al. (Eds.), Proceedings of the Second Conference on the Environmental Impact of Water Chlorination, Gatlinburg, TN, October 31-November 4, 1977. Ann Arbor Science, Ann Arbor, MI (pp. 111-122), 909 pp. (1977; 1978)

The acute toxicity of chlorine to largemouth bass (MICROPTERUS SALMOIDES) was tested at different oxidant concentrations, exposure durations and frequencies, and water temperatures. In one series of tests the fish (avg. wt. 8.50-8.60 g) were exposed to either a 90-min square wave regime (mean plateau concentrations 2.35-3.32 mg/l over a 40 min period) a 63 min low spike regime (peak concentrations about 20 min after the start of the period were 5.73-9.06 mg/l) or a 51 min high spike regime (peak TRC levels after about 8 min were 8.21-11.93 mg/l). The effects of the three different types of exposures were compared on the basis of areas under the time concentration curves (expressed as mg/l X min of TRC in which a 10 min exposure to 1 mg/l equalled 5.9 cm(2)) versus fish mortality (expressed as probits). The resulting mortality patterns were reported to be not significantly different for the three different exposure types. For fish exposed to one 90 min or 150 min square wave regime or to two 90-min regimes separated by a 2-h recovery period, the mortality curves were also closely related to the time-concentration values such that the 50% mortality level was a 200-250 mg/l x min. LC50 values calculated from mean plateau or mean total exposure levels ranged from 1.3 mg/l (mean total) for two 90-min exposure. In a third series of tests largemouth bass (4.53-4.62 g) were exposed to a single 90 min square wave regime at 24.3 C or at 13.1 C following acclimation at the same temperature. In the latter case 50% mortality occurred at 8.5 mg/l while the same level of mortality occurred at 3.5 mg/l for fish conditioned to and tested at 24.3 C. Bass subjected to the 11 C thermal shock were the least chlorine tolerant and 50% mortality occurred at less than 2 mg/l TRC. (DMO)

<249>
Laughlin, R.B., Jr., Texas A&M University, College Station, TX

Interactive Effects of Physical Factors and Hydrocarbon Exposure on the Survival, Development Rate and Growth of the Mud Crab RHITHROPANOPEUS HARRISII and the Horseshoe Crab LIMULUS POLYPHEMUS.
Ph.D. Thesis, Texas A&M University, 220 pp. (1977)

Embryos and juveniles of the horseshoe crab, LIMULUS POLYPHEMUS were exposed continuously to 0.5, 10, 25 and 50% Water-Soluble Fractions (WSF) of no. 2 fuel oil at temperatures of 20, 25 or 30 C and one salinity, 32 ppt. Exposure lasted four months. Cumulative survival was highest at 30 C and decreased with temperature. The eggs and trilobite larvae were the most sensitive stages. Respiration rates were determined for first-tailed stage animals. A multifactorial design of the three rearing temperatures and salinities of 32 ppt (rearing salinity), 20 and 10 ppt (hypoosmotic shock salinity) were used. Q10's for acclimated animals were 2.1, but at 10 and 20 ppt they were 1.8 and 1.3, respectively, for the temperature interval from 20 to 30 C. In another experiment, the zoeal stages of the mud crab, RHITHROPANOPEUS HARRISII were exposed separately to phenanthrene or naphthalene in a factorial combination with three temperatures and salinities. Phenanthrene was much more toxic than naphthalene. Low temperatures increased the toxicity, particularly for phenanthrene. Both temperature and salinity had some effect on the development rate with the former playing the predominant role. (Auth) (MU)

<250>
Laurence, G.C., National Marine Fisheries Service, Northeast Fisheries Center, Narragansett Laboratory, Narragansett, RI

Comparative Growth, Respiration and Delayed Feeding Abilities of larval Cod (GADUS MORHUA) and Haddock (MELANOGRAMMUS AEGLEFINUS) as Influenced by Temperature

<250> CONT.
During Laboratory Studies.
Marine Biol. (W. Ger.), 50, 1-7 (1978)

Comparative growth and respiration were measured during the period hatching to metamorphosis for larval cod (GADUS MORHUA) at 4, 7, and 10 C and for haddock (MELANOGRAMMUS AEGLEFINUS) at 4, 7, and 9 C. Growth was positively correlated with temperature for both species. Specific growth rates on a daily basis indicated good growth for the two species at the upper two temperatures and suppressed growth at 4 C. Respiration rates measured by oxygen consumption were similar for both species. Variable and elevated oxygen consumption at 4 C indicated physiological stress at that temperature. Delayed feeding abilities, feeding initiation, yolk absorption and morphological development related to first feeding ability were similar for both species at 7 to 10 C. Larvae could survive without food and still initiate feeding until 10 days after hatching at 7 C and until 8 days at 9 to 10 C. (Auth)

<251>
Lee, C.Y., and P. Chin, National Fisheries
University of Busan, Institute of Marine
Sciences, Busan, Korea

Effects of Temperature and Starvation on the Oxygen Consumption and Nitrogen Excretion of a Mysid, PARACANTHOMYSIS HISPIDA II.
Publ. Inst. Mar. Sci. Nat. Fish. Univ. Busan 9, 25-31 (1976)

The rates of nitrogen excretion in the form of ammonia, amino acids, total nitrogen, and oxygen consumption of a mysid, PARACANTHOMYSIS HISPIDA were measured at 23, 15 and 7 C, and the variations were also determined for starvation periods of 1 to 3 days. The weight-specific oxygen consumption in females was slightly increased with the increase of body weight. The metabolic activities of males, in general, was higher than those of females. The dominant form of excreted nitrogen was ammonia-N and considerable amounts of amino-N were excreted by both mysids. The oxygen consumption and total nitrogen excretion were significantly decreased with a temperature decrease and O:N ratio became lower as temperature was decreased. When starved, oxygen consumption and nitrogen excretion were significantly decreased and O:N ratio in females at 7 C exhibited a remarkable decline. The ratio of amino-N to the total nitrogen excreted became lower during the starved conditions. (Auth)

<252>
Lifton, W.S., and J.F. Storr, State University of
New York at Buffalo, Biology Division,
Amherst, NY

The Effect of Environmental Variables on Fish Impingement.
In Fourth National Workshop on Entrainment and Impingement, L.D. Jensen (Ed.). EA Communications, Melville, NY, (pp. 299-311), 424 pp. (1978)

Studies were conducted at the Niagara Mohawk Power Corporation's C. R. Huntley Power Station and Rochester Gas and Electric's R. E. Ginna Power Station. These two stations were chosen to contrast the differences between the two types of intake systems used. The C.R. Huntley plant is a fossil-fueled plant located near Buffalo, N.Y., on the Niagara River. The plant employs a shoreline intake system. Studies conducted there showed statistically significant correlations ($p < 0.01$) between changes in several environmental variables (including wind speed, wind direction, sky cover, and water temperature) and fish impingement. These correlations indicated important relationships between physical factors and behavior of fish species. These behaviors are triggered by wave action, turbulence, seiche, and changes in light intensity. Species studied included rainbow smelt (OSMERUS MORDAX), alewives (ALOSA PSEUDOHARENGUS), and gizzard shad (DOROSOMA CEPEDIANUM), which were the principal species impinged. The R.E. Ginna plant is a nuclear plant with an offshore intake located near Rochester, N.Y., on Lake Ontario. The effect of environmental variables (including wind direction, wind speed, sky cover, and water temperature) on fish behavior near the intake and correlated changes in impingement owing to these variables were examined. Since new regulatory guidelines require modeling of intake impacts, it is important to account for aspects of the physical environment that cause quantitative changes in impingement and to preserve those statistical parameters of the physical environment that affect impingement estimates. (Auth)

<253>
Liu, E.H., R. Sharitz, and M.H. Smith, University
of South Carolina, Department of Biology,
Columbia, SC; Savannah River Ecology
Laboratory, Aiken, SC

Thermal Sensitivities of Malate Dehydrogenase Isozymes in TYPHA.
Amer. Jour. Bot., 65, 214-220 (1978)

Two species of cattail, TYPHA LATIFOLIA L. and T. DOMINGENSIS Pers., occur naturally along the shoreline of Par Pond, an 1,128 ha impoundment subjected to intermittent thermal stress at the Savannah River Plant in South Carolina. T. DOMINGENSIS is not tolerant of the stresses imposed at the hottest section of this lake. TYPHA LATIFOLIA is established throughout the lake, but at the hottest section displays an altered morphology compared with stands from ambient areas. Both T. LATIFOLIA and T. DOMINGENSIS are electrophoretically monomorphic, and no variation in isozyme expression in ten enzyme systems was recorded in populations from Par Pond. The malate dehydrogenase (MDH) isozyme patterns for T. LATIFOLIA and T. DOMINGENSIS are identical, but their thermal sensitivities differ sharply. All six major T. DOMINGENSIS MDH isozymes are denatured by heating at 50 C; whereas, T. LATIFOLIA has three isozymes which are stable at 50 C and three isozymes which are denatured at this temperature. Tests of thermal stability are more useful than measurements of electrophoretic mobility in detecting enzyme differences and a possible biochemical basis for differences in thermal tolerance in these natural populations. (Auth)

<254>
Livingstone, D.R., Institute for Marine
Environmental Research, Plymouth, England

Anaerobic Metabolism in the Posterior Adductor Muscle of the Common Mussel MYTILUS EDULIS L. in Response to Altered Oxygen Tension and Temperature.
Physiol. Zool., 51, 131-139 (1978)

Alanine, glutamate, and succinate accumulated in the posterior adductor muscle of MYTILUS EDULIS L. when subjected to combinations of hypoxia (40-50 and 80 mm Hg) and altered temperatures (22 C and 10 C after acclimation to the field ambient temperature of 15 C). The accumulations were greater at the lower of the two oxygen tensions. The time courses of the

<254>
<254> CONT.

metabolite accumulations and subsequent declines were different for animals held at 10 C and at 22 C. The results support the hypothesis that anaerobic and aerobic pathways can operate simultaneously in the tissues of MYTILUS. Aspartate declined in response to hypoxia, and a role in anaerobic metabolism is indicated. (Auth)

<255>
Loar, J.M., J.S. Griffith, and K.D. Kumar, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN

An Analysis of Factors Influencing the Impingement of Threadfin Shad at Power Plants in the Southeastern United States.
In Fourth National Workshop on Entrainment and Impingement, L.D. Jensen (Ed.). EA Communications, Melville, NY, (pp. 245-256), 424 pp. (1978)

Data on intake design and location, plant operating procedures, water quality, numbers of fish impinged, and sampling procedures were analyzed for 27 fossil-fueled and 5 nuclear power plants located on inland water in the southeastern United States. Small clupeids (less than 9 cm), especially threadfin shad (DOROSOMA PETENENSE), comprised the majority of the fish impinged at these facilities. The parameter that was correlated most highly with shad impingement was water temperature. Maximum impingement rates occurred during the winter when intake temperatures dropped below 10 C. Analyses of differences in impingement rates between plants failed to adequately demonstrate that the magnitude of impingement at a particular plant was the result of any site-specific characteristics associated with intake design or location. High approach velocities at the traveling screens did not necessarily result in high levels of impingement. Results obtained from interunit comparisons at several plants indicate that unit and screen differences do exist, but it is unclear from existing data whether or not such interunit differences determine the magnitude of impingement losses or merely affect the distribution of impinged fish at a given intake structure. Recommendations for monitoring fish impingement include: (1) the identification of impinged fish by species, (2) the collection of data on water temperatures and various plant operational parameters, (3) the periodic analyses of localized velocity regimes near the intake, and (4) the frequent estimates of relative density of the fish population in the vicinity of the intake. Implementation of these recommendations will help not only to provide reliable estimates of total annual impingement, but also to assure that sufficient information exists for identifying the causal factors influencing impingement at a given power plant. (Auth)

<256>
Lu, J.D., Michigan State University, Ann Arbor, MI

The Dynamics of Zooplankton Populations in Western Lake Erie Including the Effect of Thermal Effluent.
Ph.D. Thesis, University of Michigan, 103 pp. (1977)

Zooplankton population dynamics in western Lake Erie including the effect of thermal effluent on population dynamics were studied over the time period 1970-1975. In general the species composition has remained constant over the past several decades. Adverse effects on zooplankton populations were noted in the discharge canal, with a decrease in abundance. Some growth enhancement in the populations have been observed at the lake stations where a small temperature increment was added to the environment. (ST)

<257>
Luning, K., and M. Neushul, Biologische Anstalt Helgoland Meeresstation, Helgoland, Germany; Marine Science Institute, University of California, Santa Barbara, CA

Light and Temperature Demands for Growth and Reproduction of Laminarian Gametophytes in Southern and Central California.
Marine Biol. (W. Ger.), 45, 297-309 (1978)

The study represents an approach to determine the specific light and temperature demands for vegetative growth and reproduction of nine laminarian species from California, some of which are environmentally and economically important. Species sampled from southern California were MACROCYSTIS PYRIFERA, LAMINARIA FARLOWII, PTERYGOPHORA CALIFORNICA, and EGREGIA MENZIESII; species occurring in central California were MACROCYSTIS INTEGRIFOLIA, HEDOPHYLLUM SESSILE, ALARIA MARGINATA, LAMINARIA DENTIGERA, AND L. SINCLAIRII. Vegetative growth was light saturated at relatively low irradiances (4 W/m2 or an illuminace of 1000 lux). Two to three times this irradiance in continuous fluorescent cool white light was needed to induce the majority of gametophytes to become fertile. Central California species had a growth optimum at 12 C and grew better at 7 C than at 20 C. Southern species had their growth optimum at 17 C and in several cases grew better at 20 C than at 7 C. (ST)

<258>
Lyutova, M.I., V.Ya. Alexandrov, and N.L. Feldman, Botanical Institute and Institute of Cytology, Laboratory of Cytophysiology, Leningrad, USSR

Increase in Cell Thermostability of Marine and Freshwater Algae under the Influence of Superoptimal Temperature.
Tsitologiya (USSR), 19, 368-374 (1977)

Short-term heating (3 to 60 min) increased the cellular heat resistance of some freshwater unicellular algae (CHLAMYDOMONAS EUGAMETOS, CHLORELLA VULGARIS, CLOSTERIUM ACEROSUM) and multicellular green (ENTEROMORPHA INTESTINALIS) and brown (ALLARIA ESCULENTA, SACCORHIZUM DERMATOIDEA) marine algae, cold resistance being decreased. (Auth)

<259>
Mackie, G.L., University of Guelph, Department of Zoology, Guelph, Ontario, Canada

Effects of Pollutants on Natality of MUSCULIUM SECURIS (Bivalvia: Pisidiidae).
Nautilus, 92, 25-33 (1978)

Laboratory experiments showed that natality of MUSCULIUM SECURIS is significantly reduced below 10 C and above 25 C with optimum reproduction close to 18 C. Road salts consisting of sodium chloride had a greater adverse effect than similar concentrations of salts consisting of calcium chloride on the natality of laboratory reared M. SECURIS. Natalities were significantly less in sulfate concentrations exceeding 100 mg/l. When reared in the field, reproduction of M. SECURIS was reduced immediately below pulp and paper outfalls and sewage and slaughter house waste discharges. It is concluded that natality is a good index for the assessment of water quality. Guidelines are

<259> CONT.

given to standardize techniques for calculating a natality index from naturally occurring populations of sphaeriids. (Auth)

<260>

Magadza, C.H.D., National Council for Scientific Research, Lusaka, Zambia

Determination of Development Period at Various Temperatures in a Tropical Cladoceran, MOINA DUBIA de Guerne and Richard.
Trans. Rhod. Scient. Ass. (Rhod.), 58, 24-27 (Not given)

The development period of MOINA DUBIA from egg to adult closely followed inverse exponential relationships with temperature (14 to 30 C). There was a noticeable tendency for development period in the egg stage to be longer than would have been expected at the 14 C test temperature. This could indicate a greater sensitivity to low temperatures in this tropical species than in other temperate and sub-tropical freshwater Cladocera. (Auth)

<261>

Major, P.F., University of California, Center for Coastal Studies, Santa Cruz, CA

Aspects of Estuarine Intertidal Ecology of Juvenile Striped Mullet, MUGIL CEPHALUS, in Hawaii.
Fishery Bull., 76, 299-314 (1978)

Behavior and distribution of schools of young striped mullet were examined in the field and laboratory. In a vertical thermal gradient, fish less than 50 mm standard length selected final mean temperatures of 30.0 to 32.4 C at the salinities tested (0, 15, 34 ppt). In the field, they were found in water with high (34.0 to 37.2 C), often near lethal temperatures in shallow pools with salinities of 2 to 30 ppt. Juveniles generally greater than 50 mm experimentally selected final mean temperatures of 29.0 C at 34 ppt salinity to 19.5 C at 0 ppt salinity. In the field, fish greater than 50 mm remained seaward of the tide line in water of lower and more uniform temperature and higher and more uniform salinity than those recorded for mullet less than 50 mm. These results were discussed in relation to feeding and predator-prey behavior. (ST)

<262>

Malouf, R.E., and W.P. Breese, Oregon State University, Department of Fisheries and Wildlife, Newport, OR

Seasonal Changes in the Effects of Temperature and Water Flow Rate on the Growth of Juvenile Pacific Oysters, CRASSOSTREA GIGAS (Thunberg).
Aquaculture, 12, 1-13 (1977)

The study was initiated to determine the feasibility of utilizing nuclear power plant effluent for culturing oysters. The effects of temperature, water flow rate, and particulate organic carbon and nitrogen suspended in seawater on the growth of immature oysters were monitored. The experiments were repeated seasonally using small clutchless spat. The results show marked seasonal changes in the growth rate of immature Pacific oysters. The growth fluctuations were independent of temperature and appeared to be related to changes in the quantity of particulate organic material suspended in the water. Growth was minimal between November and March, regardless of the temperature, and reached a maximum in July and August. There was not a consistent growth advantage to temperatures in excess of 15 C. During periods of low food availability or at low flow rates, growth was inversely related to temperature between 10 C and 23 C. Hypothetical curves relating temperature, food availability, and oyster growth are proposed. The form of these curves, which is based on observed relationships and on similar studies involving other aquatic organisms, suggest that under ideal conditions and with high food availability maximum growth might be achieved at temperatures approaching 20 C. (Auth) (ST)

<263>

Manion, P.J., U.S. Fish and Wildlife Service Sea Lamprey Control Station, Marquette, MI

Downstream Movement of Fish in a Tributary of Southern Lake Superior.
Progressive Fish Culturist, 39, 14-16 (1977)

The influence of two invironmental factors, stream flow and water temperature, on the downstream movement of four fish species in the Big Garlic River over a 12-yr period are described. Brook trout (SALVELINUS FONTINALIS) migrated after floods had subsided in the spring and during rising water in the fall at temperatures of about 10 C. Brook sticklebacks (CULAEA INCONSTANS) moved downstream chiefly in winter. Mottled sculpins (COTTUS BAIRDI) moved primarily in the winter and during floods. Yellow perch (PERCA FLAVESCENS) appeared to move generally in the fall as water levels increased and water temperatures decreased. (Auth)

<264>

Mann, R., and S.J. Glomb, Woods Hole Oceanographic Institute, Woods Hole, MA

The Effect of Temperature on Growth and Ammonia Excretion of the Manila Clam TAPES JAPONICA.
Estuarine Coastal Marine Sci., 6, 335-339 (1978)

The effect of sustained temperatures of 12, 14, 16 and 18 C on the growth and ammonia excretion of the Manila clam, TAPES JAPONICA (Deshayes, 1853) were measured over a 77-day period. Meat growth was highest at 12 C, less at 14 and 16 C, and the lowest at 18 C. No significant differences were noted in shell growth at the four temperatures. Ammonia excretion decreased from 12 to 14 C but increased markedly at 16 and 18 C. It is suggested that increased ammonia excretion is related to a change in predominant respiratory substrate concurrent with gonad production. (Auth)

<265>

Mann, R.H.K., Freshwater Biological Association, River Laboratory, East Stroke, Wareham, Dorset, England

Observations on the Biology of the Perch, PERCA FLUVIATILIS, in the River Stour, Dorset.
Freshwater Biol. 8, 229-239 (1978)

Opercular bones from 323 perch from the River Stour (England) were used for age and back-calculated growth determinations. Annuli were formed during May at the beginning of the growth period. Growth was minimal from October to April, but growth was rapid during the summer months when water temperatures rarely fell below 12 C. Female perch grew faster than males, and the growth rates of both sexes were higher than those observed in most other Eurpoean waters. Spawning occurred during late April and early May: male gonads began development in August and had attained their maximum weight in September, but the ovaries developed gradually from August until April.

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Immature perch had an annual cycle of condition with a maximum in June-July and a minimum in December-January. The condition of mature males and females was affected by the gonad cycle. (Auth) (MU)

<266>
Marais, J.F.K., University of Port Elizabeth, Department of Zoology, Port Elizabeth, South Africa

Routine Oxygen Consumption of MUGIL CEPHALUS, LIZA DUMERILI and L. RICHARDSONI at Different Temperatures and Salinities.
Marine Biol., 50, 9-16 (1978)

Oxygen consumption studies were undertaken with 3 mullet species to determine b, the exponent of w, as well as a, as indices of metabolic rate in the equation $M = aW(E+b)$, where M = metabolic rate, a = the intensity of metabolism, W = body weight, and b = the exponent of W. This was done under 5 experimental temperatures (13, 18, 23, 28, 33 C) for MUGIL CEPHALUS and LIZA DUMERILI at 1 and at 35 g/l S, and for L. RICHARDSONI at 35 g/l S only. Mean b values were approximately 0.85. The a values depended on temperature, and increased according to Van't Hoff's law except for L. DUMERILI (1 g/l S) and L. RICHARDSONI (35 g/l S) for a temperature increase from 23 to 28 C. It was found that handling had a profound influence on metabolic rate and led to considerably increased consumption rates during the first 8 h after introduction into the respiration chambers. Fasting in L. DUMERILI resulted in a total drop of 27% in oxygen consumption over a period of 6 days, of which 10% occurred over the first 24 h. Oxygen consumption displayed diurnal rhythms during the 6 day period, with lowest consumption rates at midday and midnight and highest just after sunrise and sunset. (Auth)

<267>
Margraf, F.J., Texas A&M University, College Station, TX

The Abundance and Distribution of Fishes in the Cooling-Water Canal System of an Electric Generating Station, with Emphasis on the Effect of Cooling Towers.
Ph.D. Thesis, Texas A&M University, College Station, 117 pp. (1978)

Trawl collections were taken from June 1974 to September 1975 to determine the abundance and distribution of fishes in the canal system of the P.H. Robinson Generating Station. Abundant species included bay anchovy, Gulf menhaden, Atlantic croaker, striped anchovy, spot, sand seatrout, and sea catfish. These seven species accounted for 98.5% of the total catch. Striped anchovy, bay anchovy, sea catfish, and sand seatrout had peak abundance in the intake canal during summer, but were generally absent from the discharge canal. Gulf menhaden, spot, and Atlantic croaker were most numerous during winter and were often present in abundance in the discharge canal at this time. There was evidence from length frequency data that spot and Atlantic croaker had established resident populations in the discharge during winter. In general, most fish captured in the discharge canal were recruited from the intake canal via impingement on the plant's revolving intake screens and subsequent sluicing to the discharge. Catches in the discharge canal differed little from those made prior to the construction of cooling towers. (Auth) (MU)

<268>
Martinez, M.R., and R.W. Krauss, University of the Phillipines at Los Banos, College of Sciences and Humanities, Laguna, Phillipines; Oregon State University, College of Science, Corvallis, OR

Some Growth Characteristics of SCENEDESMUS OBLIQUUS (Turp.) Kuetz.
Kalikasan, Phillip. Jour. Biol., 6, 21-32 (1977)

The response of the euryhaline green alga, SCENEDESMUS OBLIQUUS, to light, temperature, salinity stress, and supplementary organic media is presented. Steady-state cultures grew best at 30 C and an illuminance of 700 ft-c. When the temperature was lowered to 11 C, growth decreased from three doublings to one doubling per day. There was no growth at 37 C. (ST)

<269>
Matias, J.R., and J. Markofsky, Orentreich Foundation for the Advancement of Science, Inc., New York, NY; Goldwater Memorial Hospital, Roosevelt Island, NY

The Survival of Embryos of the Annual Fish NOTHOBRANCHIUS GUENTHERI Exposed to Temperature Extremes and the Subsequent Effects on Embryonic Diapause.
Jour. Exp. Zool., 204, 219-228 (1978)

Diapause embryos of NOTHOBRANCHIUS GUENTHERI were exposed to temperatures ranging from -8 to 40 C for variable durations of time, and survival, abnormalities, and developmental rates were determined. Diapause embryos were much less sensitive to temperature extremes than were other stages. Abnormalities occurred under certain temperature exposures, but were more frequent at the early stages of development. Short exposure of Diapause I embryos to -8 and 3.4 C eliminated Diapause II, while short exposure to 40 C enhanced its duration. (ST)

<270>
Matthews, W.J., University of Oklahoma, Norman, OK

Influence of Physico-Chemical Factors on Habitat Selection by Red Shiners, NOTROPIS LUTRENSIS (Pisces: Cyprinidae).
Ph.D. Thesis, University of Oklahoma, 106 pp. (1977)

Field studies were combined with single and multifactor laboratory preference tests to determine the relative influence of several physico-chemical factors on red shiner habitat selection. Temperature, pH, and total dissolved solids were the water quality factors that had the greatest potential influence, while dissolved oxygen and turbidity were of limited importance in habitat selection. Current speed was the physical factor to which red shiners responded most consistently. In the field red shiners avoided temperatures below 18 C in May and above 36 C in August. In October they were found at temperatures of 11.5 to 13.0 C. In the laboratory they showed a positive response to warm water in spring. By August, selected temperatures ranged from 26.3 to 35.1 C. In October temperatures selected in the laboaratory were the same as those in the field. (ST)

<271>
McCauley, R.W., W.W. Reynolds, and N.H. Huggins, Wilfrid Laurier University, Department of Biology, Waterloo, Ontario, Canada; Pennsylvania State University, Department of Biology, Wilkes-Barre, PA

Photokinesis and Behavioral Thermoregulation in

<271> CONT.
Adult Sea Lampreys (PETROMYZON MARINUS).
Jour. Exp. Zool., 202, 431-437 (1977)

Photokinetic responses of adult sea lampreys were used to facilitate study of their thermoregulatory behavior in a laboratory thermal gradient. Lampreys swam about actively when room lights were switched on, but attached themselves to the side walls at temperature-dependent sites in the gradient when lights were turned off. Attachment sites were significantly correlated with temperature. Acute mean preferred temperature of five lampreys, previously acclimated at 10 C, was 14.3 plus or minus 3.0 C. This is the first experimental demonstration of behavioral thermoregulation in this ancient class of jawless vertebrates (Agnatha). (Auth)

<272>
McCleave, J.D., University of Maine, Migratory Fish Research Institute and Department of Zoology, Orono, ME

Rhythmic Aspects of Estuarine Migration of Hatchery-Reared Atlantic Salmon (SALMO SALAR) Smolts.
Jour. Fish Biol., 12, 559-570 (1978)

Seasonal, diel and tidal rhythmic activity of hatchery-reared Atlantic salmon (SALMO SALAR) smolts migrating through a large estuary was studied by ultrasonic tracking of 46 individuals during two seasons. Prior to 10 May each year most smolts were inactive and remained near shore in shallow water. After 10 May nearly all smolts moved away from the release point into swift water and made rapid seaward progress. Initiation of migration each year occurred when river and hatchery water temperatures rose above 9 C. Migration in the estuary was largely passive drift, and as a result there were distinct tidal rhythms of ground ("swimming") speed and net seaward travel. There were no diel rhythms in ground speed or net seaward travel; smolts drifted seaward on the tides during both day and night. Smolts may be slightly deeper during day than night. (Auth)

<273>
McElhone, M.J., University College of North Wales, Department of Zoology, Bangor, North Wales

A Population Study of Littoral Dwelling Naididae (Oligochaeta) in a Shallow Mesotrophic Lake in North Wales.
Jour. Animal Ecol., 47, 615-626 (1978)

The population densities of three coexisting species of the Naididae, NAIS PSEUDOBTUSA, CHAETOGASTER DIASTROPHUS, and STYLARIA LACUSTRIS showed seasonal fluctuations in the littoral zone of the lake. In NAIS PSEUDOBTUSA a highly significant multiple correlation was found between density and the combined effect of both detritus availability and temperature. No significant correlation was found between the proportion of the population with a bud and temperature. An increase in food availability may promote budding, but the magnitude of the response may be dependent on temperature. Temperature may also influence the production of algae and microbes which are used as food by this species. In CHAETOGASTER DIASTROPHUS there was no significant correlation between the density and food or temperature alone, but in combination, both factors were important. (NU)

<274>
McGee, M.V., J.S. Griffith, and R.B. McLean, Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN

Aspects of the Winter Predator-Prey Relationship between Sauger and Threadfin Shad in Watts Bar Reservoir, Tennessee.
NUREG/CR-0170; ORNL/NUREG/TM-222, Oak Ridge National Laboratory, 80 pp. (1978)

The impact of cold-induced mortality and impingement of threadfin shad (DOROSOMA PETENENSE) on the food consumption and prey selection of sauger (STIZOSTEDION CANADENSE) in Watts Bar Reservoir, Tenn., was determined. Food consumption of sauger was reduced and prey selection shifted to other species after January due to the combined effects of predation, impingement, and natural mortality of cold-stressed threadfin. Laboratory digestion rate studies of sauger indicated digestion of force-fed meals of 4 to 7 g fathead minnows could proceed to 90% completion in 54 h at 5 C, 47 h at 10 C, and 25 h at 15 C. (ST)

<275>
McLaren, I.A., Dalhousie University, Biology Department, Halifax, Nova Scotia, Canada

Generation Lengths of Some Temperate Marine Copepods: Estimation, Prediction, and Implications.
Jour. Fish. Res. Bd. Can., 35, 1330-1342 (1978)

Only copepodids should be used to trace synchronous cohorts from relative abundance of stages, and only long-lived adults correctly signal new generations from size changes. From extensive published data from Loch Striven, Scotland, life cycles are thus detailed for PSEUDOCALANUS MINUTUS, MICROCALANUS PYGMAEUS, CALANUS FINMARCHICUS, CENTROPAGES HAMATUS, TEMORA LONGICORNIS, ACARTIA CLAUSI, and OITHONA SIMILIS. Generation lengths are also estimated for all but M. PYGMAEUS from temperatures in nature and from laboratory data on food-satiated development. For stage durations (D) at various temperatures (T), Belehradek's temperature function D = a(T-alpha)(E-b) is used. Temperature response can be about the same throughout a species range. With b fixed, alpha within a species can be the same for older stages as for embryonic duration, which can thus be used to estimate a for generation length even from a laboratory example at a single temperatue. If food-satiated durations are available only for some stages, it can be assumed that other stages are similar (isochronal development). Food-satiated generation lengths predicted thus from the laboratory match those inferred from the Loch Striven samples. Trophic studies may be less revealing than further work on the "intrinsic" determinants of copepod performance. Competition for food should not be assumed in studies of niches and community dynamics of marine copepods. (Auth)

<276>
McLeay, D.J., and M.R. Gordon, B.C. Research, Division of Applied Biology, Vancouver, British Columbia, Canada

Effect of Seasonal Photoperiod on Acute Toxic Responses of Juvenile Rainbow Trout (SALMO GAIRDNERI) to Pulpmill Effluent.
Jour. Fish. Res. Bd. Can., 35, 1388-1392 (1978)

Acute toxic responses to bleached kraft pulpmill effluent were compared for groups of underyearling rainbow trout (SALMO GAIRDNERI) reared under constant temperature and either a summer (16L:8D) or winter

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(8L:16D) photoperiod. Toxicity tests included a 96-h LC50 bioassay, a 4.5-h sealed-jar test, an 18-h blood-sugar stress bioassay. For all tests the threshold-effect concentration of effluent was not affected by photoperiod. Median effective concentrations for the blood-sugar, temperature tolerance, and sealed-jar tests were, respectively, greater than 0.2, 0.4, and approximately 1.4 times the 96-h LC50 value for each fish group. (Auth)

<277>
McMahon, J.W., and A.E. Docherty, Atomic Energy of Canada Limited, Chalk River Nuclear Laboratories, Chalk River, Ontario, Canada

Phytoplankton and Cooling Systems: Temperature Effects Using Different Intake and Discharge Depths.
Water Res., 12, 925-929 (1978)

The effect of depth of intake and controlled discharge of heated waters (delta T = 10 C) on a natural phytoplankton community in a cold water lake was studied using polyethylene enclosures. Changes in plankton species composition and cell concentrations were used as indicators of temperature effects. Of three intake-discharge arrangements studied (surface intake-surface discharge; deep intake-deep discharge; deep intake-surface discharge) only the first design produced statistically significant increases in plankton numbers. A deep intake-surface discharge resulted in the least biological and physical changes in the lake water. Phytoplankton species succession in the heated water was similar to patterns observed in the open lake. (Auth)

<278>
Meldrim, J.W., and J.A. Fava, Jr., Ichthyological Associates, Inc., Middletown, DE

Behavioral Avoidance Responses of Estuarine Fishes to Chlorine.
Chesapeake Sci., 18, 154-157 (1977)

Preliminary results on the avoidance responses of the estuarine fish Atlantic silverside (MENIDIA MENIDIA) and white perch (MORONE AMERICANA) to chlorine under varying conditions of temperature, salinity, dissolved oxygen, and light level are reported. Temperatures tested were ambient temperatures of the Delaware River estuary plus a delta T of 2 to 3 C. Temperature and salinity appeared to most influence the avoidance concentration. In some cases applying a delta T to the test concentration increased the avoidance concentration for both species and indicated that temperature preference can override chlorine avoidance. Results of tests using seasonal ambient temperatures showed an inverse relationship between temperature and avoidance concentration. (ST)

<279>
Middaugh, D.P., A.M. Crane, and J.A. Couch, U.S.E.P.A., Gulf Breeze Environmental Research Laboratory, Bears Bluff Field Station, John's Island, SC

Toxicity of Chlorine to Juvenile Spot, LEIOSTOMUS XANTHURUS.
Water Res. (G.B.), 11, 1089-1096 (1977)

The sensitivity of juvenile spot, LEIOSTOMUS XANTHURUS, to total residual chlorine (TRC) in flowing sea-water was investigated. Incipient LC50 bioassays, histopathology, avoidance tests and the combined effect of thermal stress and TRC were used to assess sensitivity. Estimated incipient LC50 values were 0.12 mg/l TRC at 10 C and 0.06 mg/l TRC at 15 C. Histological examination of spot used in the incipient LC50 bioassay at 15 C and sacrificed while alive indicated pseudobranch and gill damage occurred in individuals exposed to a measured TRC concentration of 1.57 mg/l. Spot exposed to lower concentrations of TRC, 0.02-0.06 mg/l at 15 C and sacrificed alive showed no consistent tissue damage. Spot demonstrated temperature dependent avoidance responses to TRC. At 10 C, a concentration of 0.18 mg/l was required for significant avoidance; at 15 and 20 C, spot showed significant avoidance of TRC concentrations as low as 0.05 mg/l. Simultaneous exposure of spot to thermal stress (5, 10 or 13 C above the acclimation temperature of 15 C) at measured TRC concentrations of 0.05-0.07 and 0.34-0.52 mg/l demonstrated a significant increase in sensitivity to TRC with increased temperature and exposure times for some of the groups tested. (Auth)

<280>
Middaugh, D.P., J.M. Dean, R.G. Domey, and G. Floyd, Gulf Breeze Environmental Research Laboratory, Bears Bluff Field Station, John's Island, SC; Belle W. Baruch Institute for Marine Biology and Coastal Research and Department of Biology, University of South Carolina, Columbia, SC; University of Texas Health Center at San Antonio, Department of Bioengineering, San Antonio, TX

Effect of Thermal Stress and Total Residual Chlorination on Early Life Stages of the Mummichog FUNDULUS HETEROCLITUS.
Marine Biol. (W. Ger.), 46, 1-8 (1978)

Effects of simultaneous short-term (7.5 to 60 min) thermal stress 24 to 34 C) and total residual chlorination (0.05 to 1.0 mg/l) on specific development stages of the mummichog FUNDULUS HETEROCLITUS (Pisces: Cyprinodontidae), were investigated. For the embryonic stages, the total number of successfully hatched larvae was used as the criterion to measure effect. For the larval stages, survival 24 h after exposure was used. In the embryonic stages, temperature was the most important main variable. Only one embryonic stage (gastrula) was confounded by second-order interactions (temperatue x duration of exposure x total residual chlorination). Both 0-day and 7-day-old larval stages showed significant higher-order interactions for all combinations of test parameters, suggesting the presence of synergistic effects of the three main experimental variables. (Auth)

<281>
Minns, C.K., J.R.M. Kelso, and W. Hyatt, Canada Centre for Inland Waters, Great Lakes Biolimnology Laboratory, Fisheries and Marine Service, Department of Fisheries and the Environment, Burlington, Ontario, Canada

Spatial Distribution of Nearshore Fish in the Vicinity of Two Thermal Generating Stations, Nanticoke and Douglas Point, on the Great Lakes.
Jour. Fish. Res. Bd. Can., 35, 885-892 (1978)

At Nanticoke, Lake Erie, 1974, mean fish density varied considerably, range 162-14,204/10,000 m3 as estimated by digital acoustic fish enumeration. At Douglas Point, Lake Huron, 1975, mean density varied less, range 108-671/10,000 m3. At both sites fish densities were generally greatest in the shallowest, 3-5 m, depths. At Nanticoke, where the nearshore has low relief, there were no distinguishable communities. At Douglas Point, where depth

<281> CONT.

increases rapidly offshore, there was evidence of benthic and pelagic communities. There was no evidence of altered fish distribution in relation to temperature. At Nanticoke there was no vertical variation in temperature and no vertical response was to be expected. At Douglas Point there was thermal stratification present in the summer and there was no apparent response. The influence of incident radiation was uncertain because of the effects of diurnal migrations. At both locations fish were clustered horizontally to varying degrees in the spring and fall, while in the summer fish were distributed more evenly. Densest clusters were usually in the vicinity of the turbulent discharge at both locations. The lack of temperature response and the similarity of Nanticoke with situations at nearby streams on Lake Erie suggest that the fish are responding to currents and perhaps topography. (Auth)

<282>
Mironova, N.V., USSR Academy of Sciences,
Zoological Institute, Leningrad, USSR

Energy Expenditure on Egg Production in Young TILAPIA MOSSAMBICA and the Influence of Maintenance Conditions on Their Reproductive Intensity.
Jour. Ichthyol., 17, 627-633 (1977)

The reproductive intensity of TILAPIA MOSSAMBICA at an age of 4-9 months was investigated at different temperatures (22, 25, 28, and 31 C) and also with insufficient and abundant food. Quantitative data were obtained on the energy expenditure of females on egg production. With abundant feeding the weight increment of females was greater than with restricted feeding. However, females experiencing a shortage of food produced more eggs. The share of eggs in the total mean daily production (expressed in terms of energy) was considerably higher in females with unfavorable feeding conditions. The reproduction of the TILAPIA was stimulated by an increase in temperature and a decrease in the food ration. (Auth)

<283>
Mitton, J.B., University of Colorado, Department
of Environmental, Population, and Organismic
Biology, Boulder, CO

Shell Color and Pattern Variation in MYTILUS EDULIS and Its Adaptive Significance.
Chesapeake Sci., 18, 387-390 (1977)

The blue mussel, MYTILUS EDULIS, may be found with some degree of pale striping on the shell. This variation was postulated to have an adaptive significance, with the morphs differing in the proportion of incident sunlight transformed into heat. The hypothesis was tested by studies of geographic variation of the frequencies of the morphs along latitudinal and tidal zone transects, comparisons of sunlit and shaded environments, and by IN VIVO temperature measurements. The data generally support the hypothesis that striped individuals attain lower temperatures when exposed to sunlight, are favored where mortality from heat stress is common, and are at a disadvantage where mortality from freezing predominates. (Auth)

<284>
Moller, H., Universitat Kiel, Institut fur
Meereskunde, Kiel, West Germany

The Effects of Salinity and Temperature on the Development and Survival of Fish Parasites.

<281>

Jour. Fish Biol., 12, 311-323 (1978)

The influence of salinity and temperature on several fish parasites (CONTRACAECUM ADHUNCUM, CRYPTOCOTYLE LINGUA, ANISAKIS sp., ACANTHOCHONDRIA DEPRESSA, LEPEOPHTHEIRUS PECTORALIS, PISCICOLA GEOMETRA, and ARGULUS FOLIACEUS) was examined. A reduction in water temperature increased the salinity tolerance of parasitic larvae as well as of adult parasites. Low temperatures, however, slowed down the activity of some parasites and reduced the chance of infecting a new host. High temperatures increased the effects of adverse salinities on parasites. The reason for reduction in numbers of species of parasites in brackish waters compared to fresh and marine waters is discussed. (ST)

<285>
Moore, M.N., D.M. Lowe, and J.M. Gee, Institute
for Marine Environmental Research, Plymouth,
England

Histopathological Effects Induced in MYTILUS EDULIS by MYTILICOLA INTESTINALIS and the Histochemistry of the Copepod Intestinal Cells.
Jour. Cons. Int. Explor. Mer, (Den.) 38, 6-11 (1978)

Localised metaplastic changes in the gut epithelial cells of MYTILUS EDULIS were found to be associated with the presence of the parasitic copepod, MYTILICOLA INTESTINALIS. These changes involved the replacement of the ciliated columnar cells by non-ciliated cuboidal cells. Experimental thermal stress induced a significant increase in the numbers of macrophages in the connective tissues of both infected and uninfected mussels, but there was no evidence of any synergistic effect in infected hosts. A number of lysosomal hydrolases are associated with the gut cells of the parasite where they may be involved in intracellular digestion. It is concluded that MYTILICOLA INTESTINALIS has no significant effect on the basic cellular functions in MYTILUS EDULIS. (Auth)

<286>
Moreira, G.S., and W.B. Vernberg, University of
Sao Paulo, Physiology Department, Sao Paulo,
Brazil; Belle W. Baruch Institute for Marine
Biology and Coastal Research and Department
of Biology, University of South Carolina,
Columbia, SC

Synergistic Effects of Environmental Variables on the Metabolism of the Copepod EUTERPINA ACUTIFRONS from Two Different Areas off the Coast of the State of Sao Paulo, Brazil.
Fish. Bull., 76, 449-455 (1978)

The metabolic rate of the copepod EUTERPINA ACUTIFRONS increased with increasing temperature up to 30 C; at 32 C, rates either leveled off or decreased. Greatest increases in respiration rates were observed between 15 and 20 C. These increases were reflected in the relatively high metabolic rates within this thermal range. At 20 C metabolic rates were not significantly different over the salinity range of 15 to 55 ppt. At 15 C the copepods were able to regulate their metabolism over a range of 25 to 55 ppt. At higher temperatures (25, 30, 32 C) rates were lower at the salinity extremes and highest at 35 ppt. Rates varied from a minimum of 4.87 to a maximum of 22.36 ul/mg/h dry weight. (ST)

<287>
Morris, R.W., University of Oregon, Department of
Biology, Eugene, OR

<287>
<287> CONT.
An Analysis of Some Meristic Characters of the
Staghorn Sculpin LEPTOCOTTUS ARMATUS Girard.
Pacific Sci., 31, 259-277 (1977)

Over a 4-year period, juvenile specimens of LEPTOCOTTUS ARMATUS were collected annually at nine stations along the Pacific coast from approximately 37 to 47 degrees N latitude. Collecting was repeated at intervals at two stations (43 degrees 24' N and 44 degrees 36' N) during the seasons in which young fish were arriving from the plankton. Meristic character counts are similar over the northern part of the range studied, but there is a well-defined cline in conditions south of 43 degrees N. The number of spines on the dorsal fin appears to be influenced very little by natural developmental conditions, if at all. At the two stations sampled at approximately monthly intervals, well-defined seasonal trends in meristic character counts appear to be related to thermal history. Freedom of independent expression of meristic characters in response to the natural developmental environment is restricted by timing of phenocritical periods and a factor of a more fundamental nature, presumably genetic. (Auth)

<288>
Muller-Feuga, A., J. Petit, and J.J. Sabaut,
E.D.F., Paris, France; I.N.R.A., Laboratory
of Physiology of Poisons, Jouy-en-Josas,
France; G.I.E.E.R.N.A.,
Saint-Andre-de-Cubzac, France

The Influence of Temperature and Wet Weight on
the Oxygen Demand of Rainbow Trout (SALMO
GAIRDNERI R.) in Fresh Water.
Aquaculture, 14, 355-363 (1978)

Multiple regression analysis was applied to a series of oxygen demand measurements on rainbow trout. It confirmed the determinant influence of temperature and size of fish under standard feeding conditions. Two types of adjustment of oxygen demand in relation to those two factors were tested, and one of them was chosen in which the temperature is under an exponential form. This allows the introduction of the Q10 concept. The value of Q10 is 3.5 when the water temperature is below 10 C and 1.7 above 12 C. (Auth)

<289>
Munda, I.M., Slovene Academy of Science,
Ljubljana, Yugoslavia

Combined Effects of Temperature and Salinity on
Growth Rates of Germlings of Three FUCUS
species from Iceland, Helgoland and the
North Adriatic Sea.
Helgo. Wiss. Meeresunters., 29, 302-310 (1977)

The growth rate of germlings of three FUCUS species (F. DISTICHUS EDENTATUS from Iceland, F. VESICULOSUS from Helgoland, North Sea, and F. VIRSOIDES from the North Adriatic Sea) was investigated under different temperature and salinity conditions. The highest growth rate and the maximum elongation factor were found at 9 C for F. DISTICHUS: in the other two species growth increased with increasing temperature. Growth decreased with dilution in the three species under consideration. A rather low tolerance to dilution was observed in F. VESICULOSUS germlings. In view of the overall distribution of the latter species the opposite was expected. It seems likely, however, that susceptible strains have developed at Helgoland, where salinity rarely drops below 30 g/l. (Auth)

<290>
Murat, J.C., and J.P. Parent, Universitate Paul
Sabatier, Laboratoire Ecophysiology Animale,
Toulouse, France

Preliminary Data on the Effects of Thermal
Acclimatization on Carp Growth and
Carbohydrate Metabolism.
Cah. Lab. Hydrobiol. Montereau (Fr.), No. 2,
23-34 (1975)

Growth and some aspects of carbohydrate metabolism were studied in carp kept during one year at constant (6, 12, 20, and 30 C) or variable temperatures according to natural seasons. The influence of temperature of acclimation on epinephrine, glucagon, and insulin effects were studied. Under the experimental conditions increase in body weight was very low in carp kept at 30 C for one year. Seasonal variations in glycogen content and carbohydrate metabolism were attenuated by constant temperature. An important and significant increase in heart glycogen was observed for the warmest temperature (30 C). Epinephrine and glucagon produced important increases in blood glucose but had little effect on glycogen content. The effect on blood glucose was more delayed and extended for low water temperatures. Insulin always gave a decrease in blood glucose but involved significant increase of liver glycogen at 6 C and on the contrary strong glycogenolysis for higher temperatures. (Auth)

<291>
Murray, A.R., University of Saskatchewan, Canada

The Ecology of Saskatchewan Sphaeriidae
(Mollusca; Bivalvia): An Evaluation of Some
Components of Their Environment.
Thesis, University of Saskatchewan (1975)

The resistance of PISISIUM CONVENTUS and P. LILLJEBORGI to lethal levels of high temperature, low dissolved oxygen, and different lake waters was assessed. Specimens were acclimated to 4 and 18 C prior to testing. PISIDIUM CONVENTUS was tested at 28, 30, and 32 C; P. LILLJEBORGI was tested at 32, 33.5, and 35 C. Each species was also tested at 32 C and at 0.1 mg O2/1, 1.0 mg O2/1, and saturation. LT50's were five to ten times longer for specimens of P. LILLJEBORGI than for P. CONVENTUS at 32 C. LT50's were increased by the higher acclimation temperature for both species and decreased by exposure to low oxygen. LT50's were decreased by exposure to slough lake water for P. CONVENTUS. Although P. LILLJEBORGI tolerated low oxygen much better than P. CONVENTUS, death at 32 C for both species was primarily caused by temperature. The relationships between the distribution and abundance of 13 species of sphaeriidae and 17 environmental variables were also evaluated. (ST)

<292>
Nelson, D.A., A. Calabrese, and J.R. MacInnes,
National Marine Fisheries Service, Northeast
Fisheries Center, Milford Laboratory,
Milford, CT

Mercury Stress on Juvenile Bay Scallops,
ARGOPECTEN IRRADIANS, under Various
Salinity-Temperature Regimes.
Marine Biol., 43, 293-297 (1977)

Juvenile bay scallops, ARGOPECTEN IRRADIANS, were exposed to various combinations of mercury (mercuric chloride: 52, 89, and 150 ppb), salinities (15, 20 and 25 ppt), and temperatures (15, 20 and 25 C). Ninety-six hour survival was significantly affected by mercury concentration and salinity, as well as by the interaction between temperature

<292> CONT.

and concentration and between temperature and salinity. Toxicity of mercury at low concentrations was enhanced by high temperature and low salinity, whereas at high mercury concentrations this effect diminished. (Auth)(ST)

<293>
Nemeth, J.C., R.A. Garrett, W.E. Imbur, and M.R. Corn, Law Engineering Testing Company

An Investigation of Thermal Impacts of a Fossil-Fueled Electric Power Plant Discharge on Seagrass Bed Communities.
Assn. Southeast. Biol. Bull., 25, 49 (Abstract only) (1978)

Investigations of the distribution, population and biomass of seagrass species, macroinvertebrates and fishes were conducted in an estuary near Panama City, Florida, to determine the effects of thermal discharge from a fossil-fueled electric power plant. Hydrographic parameters were measured to characterize salinity, dissolved oxygen and temperature conditions with depth in the study area. It was noted that heated water discharge moved to the channel and bay bottom as it exited the canal. This phenomenon was attributed to salinity differences between the discharge water and the estuary. The study results presented indicate no adverse effects on the seagrass bed communities or associated benthic and fisheries populations which can be related to thermal discharges. (Complete text)

<294>
Neuman, E., National Swedish Environment Protection Board, Research Laboratory, Oregrund, Sweden

The Growth and Year-Class Strength of Perch (PERCA FLUVIATILIS L.) in Some Baltic Archipelagoes with Special Reference to Temperature.
Drottingholm, Institute of Freshwater Research (Swed.), Report No. 55 (1976)

The effect of natural temperature variations on the yearly length increment and year-class strength of perch was studied in three areas along the Baltic coast of Sweden. From 1963-1970 operculae from about 200 perch from each area were sampled yearly for age determination and back calculation of growth. The relative strengths of year classes were calculated from the age composition of catches. The three areas were almost identical in mean growth rate, variation of growth between years, and variation between relative strengths of year classes. The mean annual growth was postively correlated with water temperature in August for the second year of life and to that in September for the adults. There was no significant correlation for the first year. Year class strength showed correlation with both water and air temperature in July and August. Yearly variation in growth and its dependence on temperature increased markedly with age. Individual variations from the mean varied widely every year. (ST)

<295>
Nevitt, J.B., and R. Hall, Oklahoma State University, Stillwater, OK

Correlation of Activity and Weight in Comet Goldfish (CARASSIUS AURATUS) at Differing Water Temperatures.
Percept. Motor Skills, 45, 81-82 (1977)

Correlations of activity and weight at three water temperatures, 20, 26, and 30 C, were examined in the comet goldfish (CARASSIUS AURATUS). For the 12 subjects general activity scores increased as water temperature increased. Heavier subjects were more active at lower temperatures while lighter subjects were more active at higher temperatures. (Auth)

<296>
Newell, R.C., L.G. Johnson, and L.H. Kofoed, Odense University, Institute of Biology, Odense, Denmark; Augustana College, Biology Department, Sioux Falls, SD

Effects of Environmental Temperature and Hypoxia on the Oxygen Consumption of the Suspension-Feeding Gastropod CREPIDULA FORNICATA L..
Comp. Biochem. Physiol., 59A, 175-182 (1978)

Specimens of CREPIDULA FORNICATA were collected from the western Limfjord, Jutland (Denmark), and acclimated to 10, 15, 20, and 25 C at a salinity of 29.7 ppt, pH 7.5, and photoperiod of 12 hr light:dark for 7 wks. Oxygen consumption was measured at a variety of test temperatures under conditions of declining oxygen tension. Following acclimation to 10 or 15 C, oxygen consumption was generally dependent upon oxygen tension at test temperatures between 10 and 27 C. Following acclimation to 20 or 25 C, dependence upon ambient oxygen changed according to the test temperature at which the rates were measured. At low test temperatures the curves were characteristic of oxyregulators (animals that can maintain a certain oxygen consumption irrespective of ambient oxygen tension). As temperatures were raised from 15 to 28 C, there was a progressive loss of respiratory independence and the curves were characteristic of oxyconformers (animals that show a rate of oxygen uptake dependent upon ambient partial pressure of oxygen). (MU)

<297>
Newell, R.C., and L.H. Kofoed, Odense University, Institute of Biology, Odense, Denmark

Adjustment of the Components of Energy Balance in the Gastropod CREPIDULA FORNICATA in Response to Thermal Acclimation.
Marine Biol. (W. Ger.), 44, 275-286 (1977)

Synchronous measurements were made of the routine rate of oxygen consumption and filtration rate of CREPIDULA FORNICATA which had been acclimated to temperatures from 5 to 25 C. The cost of activity (ul o2 consumed/h-ml seawater cleared/h), increased dramatically in individuals acclimated to 10 C and exposed to short-term increases of temperature up to 30 C. Thermal acclimation had affects on both water transport and energy expenditure. The routine oxygen consumption showed lateral translation of the rate-temperature curve which resulted in the maintenance of a relatively uniform energy expenditure despite an increase in acclimation temperature from 10 to 25 C. Because of the form of the rate-temperature curve for filtration, lateral translation in response to warm acclimation resulted in an increase in the maximal clearance rate. By means of thermal acclimatory responses of both filtration and energy expenditure, C. FORNICATA achieved a large scope for growth and reproduction during warm conditions. (ST)

<298>
Newell, R.L., and G.W. Minshall, Stearns-Roger Inc., Environmental Sciences Division, Denver, CO

Effect of Temperature on the Hatching Time of

<298> CONT.
TRICORYTHODES MINUTUS (Ephemeroptera: Tricorythidae).
Jour. Kans. Entomol. Soc., 51, 504-506 (1978)

TRICORYTHODES MINUTUS (mayfly) eggs were tested at 7.5, 12.5, 21, 23, and 28 C to determine the effect of water temperature on egg hatching. Hatching time and survival of T. MINUTUS eggs were directly related to temperature. At 7.5 C hatching began after 125 days, at 12.5 C after 54 days, at 21 C after 40 days, and at 23 C after 21 days. No hatching was observed at 28 C. Highest egg mortality occurred at the highest (28 C) and lowest (7.5 C) test temperatures. Most rapid maturation occurred at 23 C. The relationship between time of hatching and water temperature is logarithmic and predictable. (MU)

<299>
Nolan, R.A., Memorial University of Newfoundland, Department of Biology, St. John's Newfoundland, Canada

Physiological Studies with the Aquatic Hyphomycete PLEUROPEDIUM TRICLADIOIDES Isolated from the Freshwater Nematode NEOMESOMERMIS FLUMENALIS.
Mycologia, 69, 914-926 (1977)

The aquatic hyphomycete PLEUROPEDIUM TRICLADIOIDES is reported for the first time from the freshwater nematode NEOMESOMERMIS FLUMENALIS. A general physiological characterization of an isolate of this fungus is presented. The optimum temperature for growth, tested over the range 4 to 35 C, was 20 C. (ST)

<300>
Not given, U.S. Environmental Protection Agency, Region VII, Kansas City, MO

Effects of Heated Wastewater Discharges from Ft. Calhoun and Cooper Nuclear Power Stations upon Biota in the Missouri River.
U.S. Environmental Protection Agency Report (1977)

This final EPA report covers information collected over a four year period on changes in the periphyton and macroinvertebrate communities in the Missouri River in the area of the Calhoun and Cooper nuclear power stations. The total number of diatom genera increased from 24 during preoperational studies to 32 after the stations began operation. This indicates that the heated discharge may have reduced seasonal succession and helped support a more diverse diatom community. The cool-water diatom ASTERIONELLA was found at both stations in 1971, but was not identified during the postoperational studies. For the benthos studies, pre- and postoperational data at each site were compared by season and as to number of organisms, types of organisms, and community structure. Instances where postoperational differences in abundance or types between two or more stations exceeded the maximum preoperational variability for the same sampling period were noted, and differences were discussed with respect to a possible influence from the thermal discharge. (ST)

<301>
Noton, L.R., Not given

The Effect of Thermal Effluent on Phytoplankton Productivity in Lake Wabamun, Alberta.
Verh. Intl. Ver. Limnol. (Ger.), 19, 542-551 (1975)

Phytoplankton productivity was measured in situ in heated and unheated areas of Lake Wabamun, Alberta (Canada) using the C-14 uptake method. Ambient summer water temperature of the lake was about 20 C. Two electric generating stations discharged cooling water at temperatures of 8 and 15 C above ambient in summer and winter, respectively. Phytoplankton productivity in warmed waters was greater than in waters of ambient temperatures. Results of phytoplankton cell counts indicated no major differences in species composition between heated and unheated areas and cell numbers were usually similar as well. Chlorophyll a content generally corresponded with cell numbers. Differences in ortho-phosphate, nitrate-nitrogen, and silicate concentrations were not found between heated and unheated areas. Turbidity, however, was greater in heated areas, indicating that subsurface depths were receiving less light than in non-heated regions. (MU)

<302>
O'Connor, C., and J.C. Mulley, Markwell Fisheries Pty. Limited, North Sydney, Australia; The University of Sydney, School of Biological Sciences, Sydney, Australia

Temperature Effects on Periodicity and Embryology, with Observations on the Population Genetics, of the Aquacultural Echinoid HELIOCIDARIS TUBERCULATA.
Aquaculture, 12, 99-114 (1977)

The fertilization and development of HELIOCIDARIS TUBERCULATA were studied seasonally at 17, 18, 24, and 28 C. The optimum temperature for both fertilization and development varied from month to month as adult reproductive periodicity, fertility and larval developmental success were related to the seasonal ocean temperature. Observations on the population genetics of H. TUBERCULATA revealed that populations were genetically undifferentiated with no evidence for separate sympatric or allopatric races, subspecies or species which may have been morphologically indistinguishable had they existed. Consequently, geographical variations in reproductive behaviour observed between locations were probably caused, not by genetic differences, but by localized nongenetic adaptation to prevailing tempepratures. For best roe productiion, gametes and embryos should be held at the oceanic temperature corresponding to that in the locality where wild adults were collected. (Auth)(MU)

<303>
Odem, B.J., University of South Carolina, Columbia, SC

Comparative Spatial and Temporal Variations among Freshwater Littoral Meiofauna in a Reservoir Receiving Thermal Effluents (Par Pond, South Carolina).
Ph.D. Thesis, University of South Carolina, 60 pp. (1977)

Freshwater littoral meiofauna - nematodes, rotifers, ostracods, and mites - were sampled along a temperature gradient in Par Pond (Savannah River Plant). A comparison among hot, warm, and cold water sites revealed reductions in species diversity and density resulting in alteration of community structure at the thermally affected sites. Reduced densities were attributed to the direct and indirect influences of elevated temperatures at these sites. (ST)

<304>
Okland, K.A., University of Oslo, Department of Marine Biology and Limnology, Blindern, Oslo, Norway

<304> CONT.
Life History and Growth of ASELLUS AQUATICUS (L.) in Relation to Environment in a Eutrophic Lake in Norway.
Hydrobiologia (Den.), 59, 243-259 (1978)

The life cycle of the isopod, ASELLUS AQUATICUS, in Lake Ostensjovann, Norway, is described. Breeding began in spring when water temperature reached 7 to 8 C. Egg incubation time was estimated to be 23 to 35 days, corresponding to about 300 degree-days above 4 C. No growth took place from November to March-April. Growth started when water temperature reached 3 to 5 C. Three generations showed similar growth increments per degree-day above 3 C regardless of life span and temperature. The total number of degree-days above 3 C available to the generations appeared to regulate the maximum length of the specimens in the respective generations. (ST)

<305>
Olah, J., and J. Farkas, Fisheries Research Institute, Szarvas, Hungary

Effect of Temperature, pH, Antibiotics, Formalin and Malachite Green on the Growth and Survival of SAPROLEGNIA and ACHLYA Parasitic on Fish.
Aquaculture, 13, 273-288 (1978)

Twenty-four strains of SAPROLEGNIA and ACHLYA were isolated from different fish-rearing ecosystems and from diseased carp. Growth was studied over the temperature range 5 to 40 C. Most strains of SAPROLEGNIA had a growth optimum at 25 C. Growth continued down to 5 C and decreased at 30 C. Growth of ACHLYA was optimal between 25 and 35 C. Growth stopped at 5 C and at 40 C. Sensitivity and survival were determined for antibiotics and for concentrations of formalin, malachite green, and formalin-malachite green mixtures. (ST)

<306>
Olla, B.L., A.L. Studholme, A.J. Bejda, C. Samet, and A.D. Martin, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Center, Sandy Hook Laboratory, Highlands, NJ

Effect of Temperature on Activity and Social Behavior of the Adult Tautog TAUTOGA ONITIS Under Laboratory Conditions.
Marine Biol. (W. Ger.), 45, 369-378 (1978)

Experiments were conducted on the effects of high, sublethal temperature (28.7 C) on activity, social behavior, and feeding in the adult tautog TAUTOGA ONITIS held under controlled laboratory conditions. Norms of these behaviors were established during acclimation to temperatures at which these fish are commonly found (18.8 to 20.8 C). During acclimation, the fish were active and feeding throughout the day. A dominance hierarchy, based primarily on size, was established for each group, with subordinate fish being displaced from all areas of the aquarium. Under elevated temperature, changes in established norms of these behaviors were observed, with activity, feeding, aggression, and the spacing between fish showing a decrease. Following return to pre-rise temperatures, although aggression remained reduced, activity, interfish distance, and feeding approached levels established during acclimation. A comparison of these results with previous ones on young tautog is made and the significance of the findings is discussed. (Auth)

<307>
Olszewski, M.J., and J.V. Wilson, Oak Ridge National Laboratory, Oak Ridge, TN

Analysis of Economic and Energy Utilization Aspects for Waste Heat Aquaculture.
CONF-780367; In Waste Heat Aquaculture Workshop, New Brunswick, NJ. National Technical Information Service, Springfield, VA (1978)

A waste heat aquaculture system using extensive culture techniques to produce fin and shellfish is currently under investigation at the Oak Ridge National Laboratory. The system uses nutrients in waste water to grow algae and zooplankton which are fed to fish and clams. A tilapia polyculture association and the freshwater clam CORBICULA are the animals cultured in the system. The results of a net energy analysis indicated that the system appears to be economically feasible. (ST)

<308>
Onbe, T., T. Mitsuda, and Y. Murakami, Hiroshima University, Faculty of Fisheries and Animal Husbandry, Fukuyama, Japan

Some Notes on the Resting Eggs of the Marine Cladoceran PODON POLYPHEMOIDES.
Bull. Plankton Soc. Japan, 24, 85-93 (1977)

The resting egg of the marine cladoceran PODON POLYPHEMOIDES was spherical, measuring 0.15 to 0.21 mm (mean: 0.18 mm) in diameter. The outer membrane was thick and stout, with polygonal cell-like structures covering its whole surface. The egg looked dark in transmitted light, but greenish light-brown in reflex light. The resting eggs hatched at all temperatures and salinities tested: 13 to 24 C and 7.3 to 31.3 g/l S, respectively. At 24 C, the hatching appeared to be suppressed. Some eggs hatched even in freshwater. The eggs hatched after the rupture of the outer membrane along the definite latitudinal line cutting the egg at about one third of its diameter. Newly hatched young differed considerably from the young hatched from the parthenogenetic egg in their large size, with rich yolk remains within the body. (Auth)

<309>
Ouchi, K., Not given

Temperature Tolerance of Young Rockfish, SEBASTES THOMPSONI (Jordan et Hubbs).
Bull. Jap. Sea Reg. Fish. Res. Lab., 28, 1-8 (1977)

The upper incipient lethal temperature (temperature at which 50% of fish die after 24 hr) of young rockfish, acclimated to temperature between 10 and 25 C, ranged from 25.6 to 28.8 C. The ultimate upper lethal temperature was 28.6 C. (ST)

<310>
Paladino, F.V., and J.R. Spotila, State University College, Department of Biology, Buffalo, NY

The Effect of Arsenic on the Thermal Tolerance of Newly Hatched Muskellunge Fry (ESOX MASQUINONGY).
Jour. Thermal Biol., 3, 223-227 (1978)

The temperature tolerance, Critical Thermal Maxima (CTM), was significantly reduced when newly hatched muskellunge fry were reared in tanks containing 0.05, 1.0, and 5.0 ppm arsenic, as sodium arsenite ($NaAsO_2$). During swim-up (days 8-14 post hatch), CTM decreased from 32.5 C to 30.5 C for fry exposed to 0.05 ppm As, from 32.2 C to 30.0

<310>
<310> CONT.

C for fry in 1.0 ppm As and from 31.3 C to 29.3 C for fry in 5.0 ppm. The CTM for the fry exposed to As remained depressed from the onset of swim-up until the experiment was terminated. The control group also displayed a drop in CTM during swim-up from 32.4 C to 30.3 C but the CTM then slowly recovered and increased to 31.8 C on day 15. Swim-up began in all tanks on day 8 and was accompanied by a rapid increase in mortality in those fry exposed to As. Fifty percent mortality was reached 2 days after swim-up began at 5.0 ppm As, 4 days after swim-up began at 1.0 ppm, and 5 days after the onset of swim-up for 0.05 ppm. All fish exposed to As died within 7 days after the onset of swim-up. Control fish completed swim-up in 3 days (11 days after hatching), began to feed, and appeared normal. (Auth)

<311>
Panek, F.M., and C.R. Cofield, Carolina Power and Light Company, Energy and Environmental Center, New Hill, NC

Fecundity of Bluegill and Warmouth from a South Carolina Blackwater Lake.
Progressive Fish Culturist, 40, 67-68 (1978)

Data on the fecundity of bluegills (LEPOMIS MACROCHIRUS) and warmouths (L. GULOSUS) from Lake Robinson, a cooling impoundment for the Robinson Steam Electric plant, is presented. Fecundity estimates for bluegills ranged from 571 to 27,027 eggs per female and were related to total length. Bluegill fecundity was lower and diameters of mature eggs were smaller than those reported in the literature. Fecundity estimates for warmouths ranged from 798 to 34,257 eggs per female and could be expressed by a given relationship. Fecundity of warmouths as determined from this relation is similar to that for fish in other habitats. (ST)

<312>
Parker, N.C., Texas A&M University, College Station, TX

Culture of Selected Estuarine Organisms and Monitoring of Water Quality in Flow-Through Tanks Receiving Power-Plant Effluent.
Ph.D. Thesis, Texas A&M University, 404 pp. (1977)

Twenty-three species were screened for their maricultural potential. These 23 species and 22 other species were also used as biological monitors in flow-through tanks and troughs receiving effluent from the Cedar Bayou Generating Station, Texas. Growth and survival of organisms were monitored in water thermally regulated to 20, 25 and 30 C and in non-thermally-regulated water taken from the power plant discharge canal. Ambient conductivity ranged from 0 to 28 mmho/cm. RANGIA CUNEATA and MERCENARIA CAMPECHIENSIS survived and grew in water of low and fluctuating conductivity; however, low conductivity and high temperature limited survival of CRASSOSTREA VIRGINICA. PALAEMONETES PUGIO, CYPRINODON VARIEGATUS and POECILIA LATIPINNA successfully reproduced in the laboratory. Cannibalism limited the survival of penaeid shrimp and CALLINECTES SAPIDUS. C. SAPIDUS were individually housed and by molting, soft-shell crabs were produced. ICTALURUS PUNCTATUS, TRACHINOTUS CAROLINUS, ORTHOPRISTIS CHRYSOPTERA, MICROPOGON UNDULATUS and MUGIL CEPHALUS grew more rapidly maintained at ambient temperature (range of monthly means 16.5-30.1 C) than when held at temperatures regulated at 20, 25 or 30 C. High ionic content of the water, as measured by conductivity, limited survival of I. PUNCTATUS; whereas, low ionic content of water limited survival of CHAETODIPTERUS FABER, T. CAROLINUS, O. CHRYSOPTERA, LAGODON RHOMBOIDES and OPSANUS BETA. Aufwuchs accrual in the laboratory tanks was influenced by temperature, salinity and species of fish cultured. During the winter months when total gas saturation was the highest, 17 marine and estuarine fishes and P. PUGIO developed gas bubble disease. From 1973--1976, 26 species were analyzed for tissue levels of Cr, Mn, Fe, Co, Cu, Zn, As, Hg, and Pb, and chlorinated hydrocarbons and results were compared to detect annual changes in pond-cultured and laboratory-cultured organisms. Co, Mn, and Zn levels in tissue were negatively correlated with salinity. Mn, Fe, Zn and Cu in muscle of MICROPOGON UNDULATUS were negatively correlated with standard length but Hg was positively correlated with length. Hg levels in all species examined were not in excess of the acceptable FDA level for foodfish. Tissue analyses indicated that toxaphene was probably the cause of a fishkill in the winter of 1973. (Auth) (ST)

<313>
Parry, G.D., University of Melbourne, Department of Zoology, Parkville, Victoria, Australia

Effects of Growth and Temperature Acclimation on Metabolic Rate in the Limpet, CELLANA TRAMOSERICA (Gastropoda: Patellidae).
Jour. Animal Ecol., 47, 351-368 (1978)

Seasonal patterns in metabolic rate and somatic and gonadal growth rates were determined for the mid-littoral limpet CELLANA TRAMOSERICA by field sampling and laboratory studies at regular intervals over 13 months. A predictive model of the seasonal changes in metabolic rate expected due to changes in growth rate was constructed on the assumptions that (1) at a particular temperature (15, 20, 25 C) the metabolic rate required for maintenance remained constant throughout the year, and (2) the net efficiency of growth was 67%. The observed seasonal changes in metabolic rate closely fitted those predicted from changes in growth rate. Hence the concept of temperature acclimation is not necessary to explain the seasonal changes in metabolic rate of C. TRAMOSERICA. It is suggested that temperature acclimation of metabolic rate may in general be caused by temperature mediated changes in growth rate and not by a direct adaptation of metabolic rate to temperature. (Auth)

<314>
Paul, E.W., Jr., Virginia Polytechnic Institute and State University, Blacksburg, VA

Leaf Processing and the Effects of Thermal Perturbation on Leaf Degradation in the New River, Virginia.
Ph.D. Thesis, Virginia Polytechnic Institute and State University, 165 pp. (1978)

Leaf processing in the New River was studied and compared with that occurring in the thermal discharge from the Glen Lyn power plant. Leaf processing in the New River proceeded at rates approximately equivalent to those of small streams. As temperatures increased in the spring, leaf chemical losses, microbial activity, and processing rates gradually increased, suggesting that seasonal temperature changes governed all processing mechanisms studied. The effect of thermal perturbation was significant. Processing rates for faster decomposing species incubated in the thermal discharge were two to three times those of reference samples. Microbial presence and activity were enhanced in the thermal discharge to

<314> CONT.

the point that normal depression in leaf processing and microbial activity during winter, as seen at the reference station, were not seen in the thermal discharge. (ST)

<315>

Pennington, C.H., Texas A&M University, College Station, TX

Cage Culture of Channel Catfish, ICTALURUS PUNCTATUS (Rafinesque), in a Thermally Modified Texas Reservoir.

Ph.D. Thesis, Texas A&M University, 122 pp. (1977)

Channel catfish were reared during 1973 and 1974 in 1.0 m3 cages suspended in the intake canal of Trinidad Lake, a cooling reservoir for the Texas Power and Light Company's Steam Electric Generating Station at Trinidad, Texas. Results of experiments designed to evaluate effects of stocking density, cage position, protein level, feed adjustment interval, and food conversion adjustment on growth are reported. Fish were stocked at densities of 500 to 900 per cage. The effect of cage culture of the fish on water quality was also monitored. Agonistic behavior in some cages resulted in extensive mortalities. Fish culture activities increased organic content of the reservoir water and attracted large numbers of native fish. Trinidad Lake appeared unsuitable for economical channel catfish culture because high temperatures for two to three weeks in summer and low temperatures during January and February limited growth. (ST)

<316>

Platt, S., and W.J. Hauser, University of California, Division of Biological Control, Riverside, CA

Optimum Temperature for Feeding and Growth of TILAPIA ZILLII.

Progressive Fish Culturist, 40, 105-111 (1978)

TILAPIA ZILLII were fed lettuce at water temperatures ranging from 20 to 34 C to determine the impact of temperature on the feeding rate and growth and to determine the optimum temperature for each. The optimum temperature for feeding is between 28.8 and 31.4 C, when the feeding rate averaged 171% of the fish's body weight of lettuce in 24 h. The fastest growth rate was at 31.4 C, at which the fish averaged an increase of 3.42% of their body weight in 24 h. T. ZILLII should be valuable for aquatic weed control wherever water temperatures exceed 22 C for a substantial portion of the year. (Auth)

<317>

Ponomareva, Z.A., State Research Institute of Lake and River Fisheries, Leningrad, USSR

Heat Resistance of Some Scuds from the Caspian Complex Acclimatized in the Dnieper River and the Kaunas Reservoir.

Zool. Zh. (USSR), 57, 610-613 (1978)

Experiments carried out to determine the heat resistance of some amphipods showed that acclimatization of PONTOGAMMARUS ROBUSTOIDES (G.O. Sars) and P. CRASSUS (G.O. Sars) in the Kaunas Reservoir had not resulted in any ecophysiological changes in heat resistance. The heat resistance of amphipods from different populations of the same species was found to be virtually identical. The intrapopulational variability of heat resistance in the Dnieper and Kaunas populations of P. ROBUSTOIDES proved to be also identical. The heat resistance of P. ROBUSTOIDES, P.

CRASSUS and CHAETOGAMMARUS ISCHNUS (Stebbing) is shown to be species specific. (Auth)

<318>

Pritchard, G., and B. Pelchat, University of Calgary, Department of Biology, Calgary, Alberta, Canada

Larval Growth and Development of ARGIA VIVIDA (Odonata: Coenagrionidae) in Warm Sulphur Pools at Banff, Alberta.

Can. Entomol., 109, 1563-1570 (1977)

Samples of a population of ARGIA VIVIDA Hagen larvae were taken at about monthly intervals from a series of warm sulphur pools at Banff, Alberta, from June 1973 to December 1974. Changes in head capsule width and wing pad length in field-collected and laboratory-reared specimens show that the life-cycle is univoltine. Only the final (Z) instar can be recognized with certainty, but methods are described whereby the population can be divided into size classes which are thought to correspond well with the last nine larval instars. Periods of rapid growth occur in the autumn and again in the spring. Larvae overwinter in the instars U, V, W, X, and Y and the major shift to the final instar occurs in March and April. Adults emerge from April to August. In the laboratory, growth is temperature dependent until the penultimate (Y) instar and this could be a factor in the field since, although larvae can exist year-round at a constant 26 C, some larvae live in the cooler areas at the edges of the streams and pools. Entry to the final instar appears to require the long photoperiods that follow the vernal equinox. (Auth)

<319>

Provenzano, A.J., Jr., Old Dominion University, Institute of Oceanography, Norfolk, VA

Larval Development of the Hermit Crab, PAGURISTES SPINIPES Milne-Edwards, 1880 (Decapoda, Diogenidae) Reared in the Laboratory.

Bull. Marine Sci., 28, 512-526 (1978)

Larval development of laboratory reared specimens of PAGURISTES SPINIPES is described. All larvae reared at 15 C died before becoming glaucothoes. At 20 C some groups reached the glaucothoe and crab stage. Developmental stages are illustrated. (ST)

<320>

Quinn, T., G.W. Esch, T.C. Hazen, and J.W. Gibbons, Wake Forest University, Department of Biology, Winston-Salem, NC; Savannah River Ecology Laboratory, Aiken, SC

Long Range Movement and Homing by Largemouth Bass (MICROPTERUS SALMOIDES) in a Thermally Altered Reservoir.

Copeia, No. 3, 542-545 (1979)

Because of previous conflicting results regarding long-range movement of largemouth bass in Par Pond (a cooling reservoir on the Savannah River Plant, SC), additional mark-recapture studies were performed. Of 2,100 bass caught, tagged, and released, 188 (8.9%) were recaptured. Of 100 recaptures of bass originally tagged and released in heated areas, one (1%) was subsequently recaptured in an ambient area and 99 (99%) were recaptured in heated areas. The majority (75%) returned to the specific site of initial capture, despite being released at a central location. Of 88 recaptured bass originally caught and tagged at ambient sites eight (9%) had moved to thermal

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<320> CONT.

locations. A total of 13 (7%) of the 188 recaptured bass had moved between nonadjacent collecting sites which were 1,600 meters apart. The mean total length of these bass was 44 cm; that of bass recaptured at sites of original capture was 39 cm. Thus the results show that long distance movement by largemouth bass in Par Pond is exceptional rather than characteristic and occurs with greater frequency among larger individuals. (ST)

<321>
Ralph, R., and J.G.H. Maxwell, University of Aberdeen, Department of Zoology, Aberdeen, Scotland

The Oxygen Consumption of the Antarctic Limpet NACELLA (PATINIGERA) CONCINNA.
Bull. Brit. Antarct. Survey, 45, 19-23 (1977)

The oxygen consumption of the patellid limpet NACELLA (PATINIGERA) CONCINNA was measured at 5 C. The mean animal tissue dry weight was 384 mg and the oxygen consumption of a N. CONCINNA of this size was 56.6 ugO2/hr. When compared with the temperate limpet PATELLA VULGATA, N. CONCINNA does not show any cold adaptation of its oxygen consumption. (Auth)

<322>
Ralph, R., and J.G.H. Maxwell, University of Aberdeen, Department of Zoology, Aberdeen, Scotland

The Oxygen Consumption of the Antarctic Lamellibranch GAIMARDIA TRAPESINA TRAPESINA in Relation to Cold Adaptation in Polar Invertebrates.
Bull. Brit. Antarct. Survey, 45, 41-46 (1977)

The oxygen consumption of the lamellibranch GAIMARDIA TRAPESINA TRAPESINA was measured at different temperatures. At the temperature closest to the average environmental temperature, 0 C, the oxygen consumption of a 100 mg tissue dry weight individual was 37.8 ugO2/hr. This value is comparable to the oxygen consumption of temperate lamellibranchs of the same body weight measured at temperatures close to 0 C and shows no cold adaptation. Over the temperature range 0 to 5 C GAIMARDIA TRAPESINA TRAPESINA has a Q10 of approximately 2, indicating no regulation of its oxygen consumption with respect to temperature. (Auth)

<323>
Ranta, E., and I. Hakala, University of Helsinki, Lammi Biological Station, Lammi, Finland

Respiration of MYSIS RELICTA (Crustacea, Malacostraca).
Arch. Hydrobiol. (Ger.), 83, 515-523 (1978)

The oxygen consumption and carbon dioxide production of MYSIS RELICTA were studied through the life cycle in natural temperature conditions. M. RELICTA is able to maintain a stable respiration rate over the range of temperature, 2 to 7 C, in which it normally lives. In this range metabolic activity depends only on size: the physiological condition of the animal (rate of growth, stage of development) does not affect the respiration rate. The average respiratory quotient was 1 (range 0.61 to 1.17). This value does not change with age or the time of year. (Auth)

<324>
Reed, C., University of Northern Colorado, Department of Biological Sciences, Greeley, CO

Species Diversity in Aquatic Microecosystems.
Ecology, 59,, 481-488 (1978)

Aquatic microecosystems of three liters were established in replicate for eight combinations of high or low physical heterogeneity, high or low plant nutrient levels and stable or unstable temperature. Plankton succession from a pond water inoculum was observed for five mo. Microcrustacea, periphyton, and benthic organisms were sampled only at the end of the study. Final species diversity was higher for low-nutrient and for most high physical-heterogeneity systems. Stability of temperature (constant 26 C compared to cooling to 12 C at random intervals) did not affect species diversity. Numerous interactions of the three variables occurred, so that the diversity of the systems could not be predicted from the combined effects of single variables. The significance of this observation for theoretical analyses of species diversity is discussed. (Auth)

<325>
Reynolds, W.W., Pennsylvania State University, Biology Department, Wilkes-Barre, PA

Circadian Rhythms in the Goldfish CARASSIUS AURATUS L.: Preliminary Observations and Possible Implications.
Rev. Can. Biol. 36, 355-356 (1977)

In the goldfish, there is a striking parallel between the rhythms of preferred temperature and of serum prolactin levels. Also, the peak of preferred temperature occurs at a time relative to the photoperiod (latter portion of the scotophase) found most conducive to body weight gain and gonadal growth. Possible implications are discussed. (Auth)

<326>
Reynolds, W.W., Pennsylvania State University, Biology Department, Wilkes-Barre, PA

The Final Thermal Preferendum of Fishes: Shuttling Behavior and Acclimation Overshoot.
Hydrobiologia (Den.), 57, 123-124 (1978)

The concept of final preferendum is reexamined in light of data concerning acclimation in a cyclic thermal regime. Because of "shuttling behavior" to temperatures above and below the mean preferendum, and because of faster acclimation "upward" than "downward", which result in acclimation to a temperature exceeding the mean of the cycle, a fish may finally gravitate to a preferendum which does not equal acclimation temperature. It is suggested that a distinction be made between the "crossover-point" preferendum, where preference and acclimation are equal, and the "ultimate" preferendum to which a fish will ultimately gravitate. (Auth)

<327>
Reynolds, W.W., Pennsylvania State University, Biology Department, Wilkes-Barre, PA

Fish Orientation Behavior: An Electronic Device for Studying Simultaneous Responses to Two Variables.
Jour. Fish. Res. Bd. Can., 34, 300-304 (1977)

An electronic device ("Ichthyotron") is described that permits a fish to simultaneously and independently control (behaviorally regulate) two environmental variables by its movements along two axes,

<327> CONT.
among four chambers. Sample data are given for simultaneous behavioral thermoregulation, light intensity preferences, and locomotor activity rhythms in largemouth bass (MICROPTERUS SALMOIDES) and smallmouth bass (MICROPTERUS DOLOMIEUI). (Auth)

<328>
Reynolds, W.W., Pennsylvania State University, Biology Department, Wilkes-Barre, PA

Fever and Antipyresis in the Bluegill Sunfish, LEPOMIS MACROCHIRUS.
Comp. Biochem. Physiol., 57C, 165-167 (1977)

Bluegills develop a behavioral fever (increase in preferred temperature) of about 3 C when injected with killed gram-negative bacteria, AEROMONAS HYDROPHILA. The antipyretic drug acetaminophen, when dissolved in the ambient water, counteracts the febrile response to bacterial pyrogen. Injection of sterile pyrogen-free saline, or dissolution of acetaminophen in the ambient water of afebrile thermoregulating bluegills, does not significantly affect their preferred temperature. (Auth)

<329>
Reynolds, W.W., and M.E. Casterlin, Pennsylvania State University, Biology Department, Wilkes-Barre, PA

Ontogentic Change in Preferred Temperature and Diel Activity of the Yellow Bullhead, ICTALURUS NATALIS.
Comp. Biochem. Physiol., 59A, 409-411 (1977)

In an electronic thermoregulatory shuttlebox, the (24 hr) mean preferred temperature of 12 adult yellow bullheads was 27.6 C, while that of 12 juveniles was 28.8 C; the mean for all ages was 28.4 C (final preferenda). Mean preferred temperatures differed by no more than 0.4 C between photophase (day) and scotophase (night) of the light cycle. Adult bullheads were nocturnal (most active during the two 4-hr "dusk" periods centered about the light-dark and dark-light transitions. (Auth)

<330>
Reynolds, W.W., and M.E. Casterlin, Pennsylvania State University, Biology Department, Wilkes-Barre, PA

Behavioral Thermoregulation and Diel Activity in White Sucker (CATOSTOMUS COMMERSONI).
Comp. Biochem. Physiol., 59A, 261-262 (1978)

In an electronic thermoregulatory shuttlebox, eleven white suckers (CATOSTOMUS COMMERSONI) were tested individually for three-day periods, controlling water temperatures by their movements between chambers monitored by photocells. Eighty-nine percent of locomotor activity (light beam interruptions) occurred during darkness under an L:D 12:12 photoperiod. Preferred temperatures ranged from 22.8 to 26.1 C, and were slightly higher during the day (mean = 24.2 C, mode = 25 C) than at night (mean and mode = 24 C). (Auth)

<331>
Reynolds, W.W., and M.E. Casterlin, Pennsylvania State University, Department of Biology, Wilkes-Barre, PA

Complementarity of Thermoregulatory Rhythms in MICROPTERUS SALMOIDES and M. DOLOMIEUI.
Hydrobiologia (Den.), 60, 89-91 (1978)

Largemouth (MICROPTERUS SALMOIDES) and smallmouth (M. DOLOMIEUI) blackbasses tested in an electronic shuttlebox exhibited behavioral thermoregulatory rhythms which were temporally complementary. With a LD 12:12 photoperiod, M. DOLOMIEUI exhibited a preferred-temperature peak of 30.1 C during the latter portion of the photophase, when M. SALMOIDES reached a minimum of 27.1 C. M. DOLOMIEUI exhibited a minimum of 26.6 C during the latter portion of scotophase, while M. SALMOIDES remained at a significantly higher plateau of about 29 C, with a peak of 29.5 C at the midpoint of scotophase. The phase relations of the thermoregulatory rhythms relative to photoperiod suggest that they are endogenously timed circadian rhythms entrained by photoperiod. The thermotemporal complementarity of these rhythms suggests an aspect of niche segregation between these largely sympatric cogeneric species. (Auth)

<332>
Reynolds, W.W., and M.E. Casterlin, Pennsylvania State University, Biology Department, Wilkes-Barre, PA

Effect of Temperature on the Growth Rate of GRIFFITHSIA TENUIS C. Agardh (RHODOPHYTA: CERAMIALES).
Hydrobiologia (Den.), 56, 225-227 (1977)

Clonal cultures of GRIFFITHSIA TENUIS were grown for 18 days (Erdschreiber solution, LD 12 : 12, 2200 lux) at 13, 18, 22 and 25 C. The optimum temperature for growth (increase in number of cells) under these conditions was 22 C. (Auth)

<333>
Reynolds, W.W., and M.E. Casterlin, Pennsylvania State University, Biology Department, Wilkes-Barre, PA

Behavioral Thermoregulation in the Rock Bass, AMBLOPLITES REPESTRIS.
Comp. Biochem. Physiol., 60A, 263-264 (1978)

Rock bass thermoregulating in an electronic shuttlebox exhibited a modal final preferendum of 30 C (range 26 to 34 C, midpoint 30 C, median 29 C, mean 29.4 C). This species did not exhibit any significant difference between day and night, either in preferred temperature or in locomotor activity. (Auth)

<334>
Reynolds, W.W., and M.E. Casterlin, Pennsylvania State University, Biology Department, Wilkes-Barre, PA

Estimation of Cardiac Output and Stroke Volume from Thermal Equilibration and Heartbeat Rates in Fish.
Hydrobiologia (Den.), 57, 49-52 (1978)

Cardiac output and stroke volume were estimated for a 200 g largemouth blackbass (MICROPTERUS SALMOIDES) by a modified whole-body thermodilution method using the relation between thermal equilibration rates and heartbeat frequencies. The reciprocal of the thermal time constant, k(/min), was related to the heartbeat frequency, F (beats/min), by the equation $k = 0.00146F + 0.309$; the slope is the weight-specific heat transfer constant (cal/C-min-g). Stroke volume was 0.292 ml (0.00146 ml/g body weight), yielding cardiac output values ranging from 44 ml/kg-min (at 30 beats/min) to 158 ml/kg-min (at 108 beats/min), or 4.8 to 15.8% of body weight. Active (convective) heat transfer due to blood flow constituted an estimated 11 to 34% (mean 22.5%) of total heat transfer, depending on

<334>
<334> CONT.

heartbeat frequency; this variability constitutes physiological thermoregulation. (Auth)

<335>
Reynolds, W.W., and M.E. Casterlin, Pennsylvania State University, Department of Biology, Wilkes-Barre, PA

Behavioral Thermoregulation by Ammocoete Larvae of the Sea Lamprey (PETRCMYZON MARINUS) in an Electronic Shuttlebox.
Hydrobiologia (Den.), 61, 145-147 (1978)

Ammocoete larvae of the sea lamprey PETROMYZON MARINUS, a member of the primitive vertebrate class Agnatha, were tested for thermoregulatory behavior in an electronic shuttlebox (ichthyotron). The final preferendum derived from pooled data for 24 individually tested ammocoetes was characterized by a mean of 13.6 C, a mode and median of 14.0 C, and a range of voluntarily occupied temperatures from 10 to 19 C over a three-day period. (Auth)

<336>
Reynolds, W.W., M.E. Casterlin, and J.B. Covert, Pennsylvania State University, Department of Biology, Wilkes-Barre, PA; Pennsylvania State University, Department of Biology, Hazleton, PA

Behavioural Fever in Teleost Fishes.
Nature, 259, 41-42 (1976)

Preferred temperatures were monitored for eight bluegill and two largemouth bass before and following injection with killed AEROMONAS HYDROPHILA cells. Hourly occupied temperatures were tabulated for fish individually tested in an electronic thermoregulatory shuttlebox. The temperature preferendum for all fish was approximately 30 C. All bacteria-injected fish showed a significant increase in preferred temperature: 2.6 C for all test fish, 2.7 C for bluegill, and 2.1 C for the bass. Controls showed no increase. Thus bluegill and largemouth bass exhibited a behavioral fever. (ST)

<337>
Reynolds, W.W., M.E. Casterlin, and J.B. Covert, Pennsylvania State University, Biology Department, Wilkes-Barre, PA; Pennsylvania State University, Biology Department, Hazleton, PA

Febrile Responses of Bluegill (LEPOMIS MACROCHIRUS) to Bacterial Pyrogens.
Jour. Thermal Biol., 3, 129-130 (1978)

Bluegill exhibited a mean increase in preferred temperature of 2.5 C following intraperitoneal injection of endotoxin from the gram-negative bacterium ESCHERICHIA COLI. Intraperitoneal injection of killed gram-positive STAPHYLOCOCCUS AUREUS caused a mean increase of 2.6 C. These febrile responses are similar to the 2.7 C increase in response to injection of killed gram-negative AEROMONAS HYDROPHILA. (Auth)

<338>
Reynolds, W.W., M.E. Casterlin, J.K. Matthey, S.T. Millington, and A.C. Ostrowski, Pennsylvania State University, Biology Department, Wilkes-Barre, PA

Diel Patterns of Preferred Temperature and Locomotor Activity in the Goldfish CARASSIUS AURATUS.
Comp. Biochem. Physiol., 59A, 225-227 (1978)

Goldfish thermoregulating in an electronic shuttlebox device exhibited a bimodal (crepuscular) rhythm of locomotor activity (peaks at the beginning and end of the dark period) and a unimodal (nocturnal) peak of preferred temperature during the latter half of the dark period. There was no direct relationship between temperature and activity level within the preferred-temperature range of 26 to 30 C. The preferred temperature peak (29.7 C) occurred at a time (pre-dawn) most conducive to increase in body weight and gonosomatic index in goldfish subjected to an exogenously cycled thermal regime. (Auth)

<339>
Reynolds, W.W., M.E. Casterlin, and S.T. Millington, Pennsylvania State University, Biology Department, Wilkes-Barre, PA

Circadian Rhythm of Preferred Temperature in the Bowfin AMIA CALVA, a Primitive Holostean Fish.
Comp. Biochem. Physiol., 60A, 107-109 (1978)

In an electronic thermoregulatory shuttlebox, the bowfin exhibited an endogenous circadian rhythm of preferred temperature, with a peak of 32.0 C during the day and a minimum of 28.8 C at night. The 24-hr mean preferred temperature (final preferendum) was 30.5 C; the diurnal mean was 31.3 C and the nocturnal mean was 29.6 C. There is no clear rhythm of locomotor activity evident in this species; diurnal and nocturnal activity did not significantly differ as measured by two independent methods. (Auth)

<340>
Reynolds, W.W., and J.B. Covert, Pennsylvania State University, Department of Biology, Wilkes-Barre, PA; Pennsylvania State University, Department of Biology, Hazleton, PA

Survival Value of Fever in Fish.
Nature, 267, 43-45 (1977)

Goldfish were tested in an electronic thermoregulatory apparatus for survival at four temperatures after intraperitoneal injection with live AEROMONAS HYDROPHILA. A nominal 28 C baseline preferred temperature and a 2.5 C febrile elevation value were used for comparison purposes. Three groups of 25 fish were tested at fixed temperatures of 25.5, 28.0, and 30.5 C for 72 h. Goldfish maintained at a febrile temperature of 30.5 C had the highest survival rate (84%), while only 64% survived at 28.0 C and 24% at 25.5 C. A control group of 10 fish, injected only with sterile saline, all survived at 25.5 C. Another 10 fish injectd with live A. HYDROPHILA and allowed to thermoregulate in the shuttlebox attained an unexpectedly high mean increase of 4.8 C. There was no significant difference among the growth curves of A. HYDROPHILA cultures maintained at 28, 30, and 33 C. Thus fever significantly enhanced the survival of goldfish. (ST)

<341>
Reynolds, W.W., J.B. Covert, and M.E. Casterlin, Pennsylvania State University, Department of Biology, Wilkes-Barre, PA

Febrile Responses of Goldfish CARASSIUS AURATUS to AEROMONAS HYDROPHILLA and to ESCHERICHIA COLI Endotoxin.
Jour. Fish Diseases, 1, 1-4 (1978)

Goldfish were injected with a purified endotoxin from the bacterium, ESCHERICHIA COLI, to determine whether it would induce a

<341> CONT.

febrile response similar to that caused by AEROMONAS HYDROPHILA. Thirty goldfish wieghing about 20 g each were tested individually in an electronic thermoregulatory shuttlebox. The baseline preferred temperature was 27.9 C. Saline injection produced no significant change in preferred temperature. Live A. HYDROPHILA stimulated a mean febrile increase of 4.8 C, while the E. COLI endotoxin caused a febrile response of 5.9 C above baseline. (ST)

<342>

Richard, P., Ecole Pratique des Hautes Etudes, Laboratoire de Biochimie et Ecologie des Invertebres Marins, Station Marine d'Endoume, Marseille, France

Effect of Temperature on Growth and Molting of PALAEMON SERRATUS in Relation to Their Size.
Aquaculture, 14, 13-22 (1978)

The effects of temperature on growth and on the duration of the molt cycle and intermolt stages of PALAEMON SERRATUS were examined in relation to body size under controlled conditions in the laboratory. Over the size range studied, the optimum temperature for growth was 22 C. When the temperature differed from this optimum, young shrimp were less affected than old ones. Growth of the smallest shrimp was most depressed by extremely low temperatures; high temperatures acted negatively on the growth of older shrimp. The duration of the molt cycle was directly and linearly related to shrimp length; increasing temperature shortened it according tc a hyperbolic curve, with a greater effect on the largest animals. Neither body size nor temperature significantly affected the relative duration of the molt stages. (Auth)

<343>

Richard, P., Ecole Pratique des Hautes Etudes, Laboratoire de Biochimie et Ecologie des Invertebres Marins, Station Marine d'Endoume, Marseille, France

Tolerance of PALAEMON SERRATUS (Pennant): Influence of Size and Acclimation.
Jour. Exp. Mar. Biol. Ecol. (Neth.), 35, 137-146 (1978)

Prawns of different body size acclimated at different temperatures (13, 17, 21, and 25 C) were tested for high and low temperature tolerance. Time-temperature curves based on 50% survival showed an increase in low temperature tolerance and a decline in high temperature tolerance with increasing body size, but the upper and lower lethal temperatures of the different size groups tested for each acclimation temperature were similar. Acclimation to high and low temperatures increased tolerance to extremely high and low temperatures. Acclimation at 21 C appeared to ensure the greatest tolerance to temperatures above 30 C. (ST)

<344>

Richards, F.P., and R.M. Ibara, Ecological Analysts, Inc., Melville, NY; Southeastern Massachusetts University, Biology Department, North Dartmouth, MA

The Preferred Temperatures of the Brown Bullhead, ICTALURUS NEBULOSUS, with Reference to Its Orientation to the Discharge Canal of a Nuclear Power Plant.
Trans. Amer. Fish. Soc., 107, 288-294 (1978)

Brown bullheads acclimated to temperatures between 3.5 and 28 C and tested in a thermal gradient trough usually preferred water

<341>

tempertures above their respective acclimation temperatures. Fish tended to gravitate toward higher temperatures the longer they remained in the gradient; final preferendum was 27.3 C. Laboratory results are consistent with observed movements of Connecticut River brown bullheads into the thermal discharge canal of a power plant during autumn. It appears from both laboratory and field studies that a "temperature trap" keeps bullheads in the warm discharge canal during winter. However, brown bullheads leave the canal in spring sooner than would be predicted from temperature preference data alone. (Auth)

<345>

Rodgers, J.H., Jr., D.S. Cherry, K.L. Dickson, and J. Cairns, Jr., Virginia Polytechnic Institute and State University, Blacksburg, VA

Influence of Thermal Effluent on Population Dynamics of Asiatic Clam (CORBICULA MANILENSIS) in the New River, Virginia (Mollusca: Bivalvia).
Assn. S.E. Biol. Bull., 25, 48 (Abstract only) (1978)

Successfully overcoming physical and ecological barriers, CORBICULA MANILENSIS extended its range to include the New River, Giles County, Virginia, in 1975. Upstream invasion rates have been calculated at approximately nine river miles per year although factors or agents of dispersion have not been discerned. Population density beyond the area of influence of thermal effluent from a coal-fired power plant drastically declined during severe low water temperatures (0.0 C) in the winter of 1976. However, Asiatic clam density remained relatively stable within the thermal effluent. Size frequency analysis revealed population restructuring during subseqent recovery in the following year. The influence of thermal discharge upon the population dynamics and ecology of the clam is discussed. (Complete Text)

<346>

Rodhouse, P.G., The University of Southampton, Department of Oceanography, Southampton, England

Energy Transformations by the Oyster OSTREA EDULIS L. in a Temperate Estuary.
Jour. Exp. Mar. Biol. Ecol. (Neth.), 34, 1-22 (1978)

The energy budget of the oyster OSTREA EDULIS in the estuary of the Beaulieu River, England, is described. Growth was approximated by the von Bertalanffy growth model. Oxygen consumption and filtering rate of oysters collected in winter increased with temperature. Tests were conducted over the range of temperatures in the estuary, 6.9 to 23.6 C. (ST)

<347>

Rogers, B.A., University of Rhode Island, Kingston, RI

Temperature and the Rate of Early Development of Striped Bass, MORONE SAXATILIS (Walbaum).
Ph.D. Thesis, University of Rhode Island, 218 pp. (1977)

Temperature was found to have a strong effect on the rate of growth and duration of life stages in larval striped bass, MORONE SAXATILIS. Larvae deprived of food following yolk absorption decreased in length and dry weight at a rate that increased with increasing temperature. Growth in weight and length following early

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<347> CONT.

and delayed feeding increased at a rate which was temperature dependent. Physiological growth optima for embryonic development at 18 C and from 18 to 21 C for yolk absorption were proposed. Growth rates among feeding larvae after yolk absorption were highest at 21 C. (NU)

<348>
Rogers, G.D., NALCO Environmental Sciences, Lincoln, NB

Entrainment of Crustacean Zooplankton through Port Calhoun Station.
In Fourth National Workshop on Entrainment and Impingement, L.D. Jensen (Ed.). EA Communications, Melville, NY, (pp. 141-158), 424 pp. (1978)

Entrained crustacean zooplankton were studied at Fort Calhoun Station (near Blair, Nebraska) from October 1973 through June 1977 to evaluate the effects of condenser passage on zooplankton survival. Live-dead separations were performed on duplicate samples obtained from the station's intake and discharge areas with a filter pump system. The separations were performed at 0, 4, and 24 hours following condenser passage. Thermal stress appeared to be the principal factor reducing zooplankton viability immediately following condenser passage (0 hours). On 17 sampling dates when heat was not being exchanged across the condenser, mechanical damage accounted for an average increase in immotility of 1.1% for the 71 dates when the station was generating electricity, a 3.8% increase in immotility was observed. The relationship between viability and thermal stress at 0 hours was less evident at 4 and 24 hours. During the entire study period, increases in immotility at 0 hours ranged from 0.0 to 16.0% and averaged 3.3%. The station used an average of 2.5% (SD, 1.02) of the Missouri River flow for cooling. Assuming homogeneous distribution of zooplankton in the river, station operation decreased the viability of the total Missouri River zooplankton community passing the station by an average of 0.1%. (Auth)

<349>
Ross, D.H., and R.W. Merritt, Michigan State University, Department of Entomology, East Lansing, MI

The Larval Instars and Population Dynamics of Five Species of Black Flies (Diptera: Simuliidae) and Their Responses to Selected Environmental Factors.
Can. Jour. Zool., 56, 1633-1642 (1978)

The larval instars of four species of black flies were determined. PROSIMULIUM FUSCUM and PROSIMULIUM MIXTUM had seven instars; however larvae of these PROSIMUDIUM spp. passed through only six instars when development occurred at warmer temperatures. SIMULIUM VITTATUM and STEGOPTERNA MUTATA had seven and six larval instars, respectively. The instars of CNEPHIA DACOTENSIS could not be positively segregated. Stream temperature was the most important physical factor regulating larval black fly population dynamics, determining hatching time and developmental rates. PROSIMULIUM MIXTUM/FUSCUM larvae required 240 (day-degrees) above 0 C for maturation, while ST. MUTATA and C. DACOTENSIS needed 250 to 275 and 475 day-degrees, respectively. (Auth)(NU)

<350>
Ross, J., P.M. Powles, and M. Berrill, Trent University, Department of Biology, Peterborough, Ontario, Canada

Thermal Selection and Related Behavior in Larval Yellow Perch (PERCA FLAVESCENS).
Canadian Field-Naturalist, 91, 406-410 (1977)

Thermal preferenda and behavior of larval yellow perch (PERCA FLAVESCENS) were observed at successive developmental stages in a vertical thermal gradient. Newly hatched larvae acclimated to 20, 23, and 25 C selected 24.3, 24.2, and 21.7 C respectively. Preferenda did not differ significantly with developmental stage to day 24. Prior to swim bladder inflation, equilibrium required a combination of sinking and locomotory activity. After inflation (7 to 10 days from hatching at 23 C), vertical position was regulated by bladder control and blundering into warm water was reduced. This maladaptive behavior in response to elevated temperatures (rising to very warm surface layers) is described and discussed. (Auth)

<351>
Rymis, G.L., Jr., Clemson University, Water Resources Research Institute, Clemson, SC

Density and Distribution of Benthos in Lake Keowee, South Carolina.
Ph.D. Thesis, Clemson University, 78 pp. (1975)

Density and distribution of benthic macroinvertebrates were studied from August, 1971, to August, 1973, in Lake Keowee, a large newly formed impoundment in northwestern South Carolina scheduled to receive discharges of heated water. The effects of depth, station location, and season on density and taxonomic composition of benthos were examined. Total numbers of benthos varied inversely with depth. Abundance was affected by location of sampling sites within the lake, being lower in the discharge canal and proximal areas than in the intake canal and control areas. Station differences were probably related to variations in the particle size distribution and organic content of the substrate. The differences among substrates resulted from preimpoundment construction activities in the discharge area. Total density generally had three peaks, in the spring, summer, and autumn. The dipterous families Chironomidae and Chaoboridae were the major taxa. Chironomids were most abundant at 5 m, and chaoborids were most numerous at 20 m. Temperature, dissolved oxygen, and other water quality parameters did not vary significantly among the stations. (Auth)

<352>
Ryther, J.H., and R. Mann, Woods Hole Oceanographic Institution, Woods Hole, MA

Bivalve Mollusc Culture in a Waste Recycling Aquaculture System.
WHOI-77-59 (unpublished manuscript) (1977)

Progress on the development of a waste recycling aquaculture system at Woods Hole Oceanographic Institution is reported. In the present system mixtures of secondary treated sewage effluent and seawater are used to mass culture marine phytoplankton on a continuous basis in large outdoor ponds. The phytoplankton is then fed to filter feeding bivalve molluscs. The effluent from the mollusc culture tanks is passed through cultures of macroscopic red algae to effect final removal of excess and excreted nutrients. During the 1976-1977 fiscal year work centered on the effects of physical parameters on optimizing shellfish growth. Work on monitoring of phytoplankton species predominance in mass algal cultures has continued. Individual reports focus on the

<352> CONT.
effect of temperature and enrichment on species competition in mass cultures of marine phytoplankton, growth and gametogenesis of CRASSOSTREA GIGAS and OSTREA EDULIS grown at sustained elevated temperature, growth of MYTILUS EDULIS, ARGOPECTEN IRRADIANS, C. GIGAS, O. EDULIS, and TAPES JAPONICA in a waste recycling aquaculture system, and the effect of substrate particle size on growth of T. JAPONICA. (ST)

<353>
Salih, T.M., and J.N.R. Grainger, Trinity
College, Department of Zoology, Dublin,
Ireland

The Effect of the Rate of Change of Temperature on the Resistance of ASELLUS AQUATICUS (L.) to High Lethal Temperatures.
Jour. Thermal Biol., 3, 121-123 (1978)

The heat resistance of adult ASELLUS AQUATICUS increased with increasing acclimation temperatures which ranged from 5 to 25 C. However, 20 C-acclimated animals heated to 35 C at a rate of 1 C per 4 min were less resistant at 35 C than similar individuals placed directly at 35 C. Similarly acclimated animals which were slowly heated to 30 C and then suddenly placed at 35 C showed increased heat acclimation in the more resistant individuals. The results indicate that when 20 C-acclimated individuals are subjected to a steadily rising temperature, further acclimation takes place (especially in the more resistant individuals). When 30 C is reached a little further acclimation takes place in heat sensitive individuals. Above 30 C the animals are adversely affected and this becomes progressively more marked as 35 C is approached. (Auth)

<354>
Samant, S., and R.A. Agarwal, Gorakhpur
University, Department of Zoology,
Gorakhpur, India

Effect of Some Environmental Factors on Survival and Activity of Fresh Water Bivalve LAMELLIDENS CORRIANUS.
Indian Jour. Exp. Biol., 16, 26-28 (1978)

The effect of change in temperature, pH and salinity on the rhythmic activity and survival of the bivalve LAMELLIDENS CORRIANUS showed that the animals survive very well between 30 and 35 C, the temperatures which are also favorable for high rhythmic activity. While the animals could tolerate a wide range of pH, the preferred pH of 7.9 is the same as that of the blood. Studies with different salinities showed that these animals prefer a hypo-osmotic environment. A correlation has been found to exist between the survival of the animals and the environmental parameters. (Auth)

<355>
Sander, F., and R.A. Moore, McGill University,
Bellairs Research Institute, St. James,
Barbados; University of the West Indies,
Cave Hill Campus, Barbados

Comparative Respiration in the Gastropods MUREX POMUM and STROMBUS PUGILIS at Different Temperatures and Salinities.
Comp. Biochem. Physiol., 60A, 99-105 (1978)

The respiratory responses of the marine snails MUREX POMUM and STROMBUS PUGILIS to different temperatures and salinities were monitored. The b value for MUREX at ambient temperature and salinity was 0.97, with a negative exponent of -0.03. Their rates of oxygen uptake between approximately 23 and 32 C rose and fell with increased and decreased temperature respectively. Both species appear to be stenohaline osmoconformers which do not expend extra energy above and below their optimum salinity range. (Auth)

<356>
Sanders, J.E., K.S. Pilcher, and J.L. Fryer,
Oregon State University, Department of
Microbiology, Corvallis, OR

Relation of Water Temperature to Bacterial Kidney Disease in Coho Salmon (ONCORHYNCHUS KISUTCH), Sockeye Salmon (O. NERKA), and Steelhead Trout (SALMO GAIRDNERI).
Jour. Fish. Res. Bd. Can., 35, 8-11 (1978)

Juvenile coho salmon (ONCORHYNCHUS KISUTCH), sockeye (O. NERKA), and steelhead trout (SALMO GAIRDNERI) were infected by intraperitoneal injection of a suspension of the causative organism of bacterial kidney disease at seven experimental temperatures from 3.9 to 20.5 C. In coho salmon and steelhead trout percent mortality was maximal (78 to 100%) in the range of 6.7 to 12.2 C. As the temperature increased above 12.2 C mortality declined progressively; at 20.5 C it was only 8 to 14%. The two highest temperatures had some suppressing effect on the disease, which was greatest at 20.5 C. In sockeye salmon this was not apparent, as percent mortality was essentially 100% at all temperatures from 6.7 to 20.5 C; this species appeared to be highly susceptible to the disease agent. Temperature also influenced the mean number of days between infection and death. This interval was shortest in all three species of salmonids at the higher temperatures, varying from 21 to 34 days at 15.0 to 20.5 C. It increased progressively as temperature decreased below this range; at 6.7 C it varied from 60 to 71 days among the three species. (Auth)

<357>
Sastry, A.N., and S.L. Vargo, University of Rhode
Island, Graduate School of Oceanography,
Kingston, RI; University of Maryland,
Chesapeake Biological Laboratory, Solomons
Island, MD

Variations in the Physiological Responses of Crustacean Larvae to Temperature.
In Physiological Responses of Marine Biota to Pollutants, F.J. Vernberg et al. (Eds.). Academic Press, Inc., New York, (pp. 401-423) (1977)

Variation in the response of seven species of crustaceans (CANCER BOREALIS, CANCER IRRORATUS, and HOMARUS AMERICANUS from the sublittoral zone, and PAGURUS LONGICARPUS, PALAEMONETES PUGIO, PANOPEUS HERBSTII, and RHITHROPANOPEUS HARRISII from estuarine waters) with stage of development, season of hatching, species, culture conditions, and geographic origin were determined in the laboratory. Temperature and salinity limits, as well as the optimal combination for development, varied interspecifically. Generally, sublittoral species completed development over a narrower range of temperature and salinity than estuarine species. Limits for complete development also varied depending upon the prior experience of the eggs. Larvae cultured under constant and cyclic temperature regimes differed in their survival and time for complete development. Larvae from geographically separated populations exhibited differences in their survival and time for complete development. Within the tolerance range of a species, the metabolic

<357>
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response to temperature varied, but each species had a characteristic overall response. The metabolic response patterns of the larvae varied when they were cultured under cyclic temperatures. Cyclic temperature regimes increased the tolerance of some species to warmer temperatures, extended their temperature range for metabolic compensation compared to those cultured under constant conditions, and also increased larval survival. Acute temperature tolerance limits varied intra- and inter-specifically with estuarine species tolerating higher temperatures than sublittoral species. These variations should be considered in the application of laboratory bioassay results to the assessment of the effects of heavy metal, organic, and thermal pollution on a population or community. (ST)

<358>
Scarlato, O.A., Zoological Institute of the Academy of Science, Leningrad, USSR

Bivalve Molluscs and Temperature as an Agent Determining Their Geographical Distribution.
Malacologia, 16, 247-250 (1977)

Based on analyses of temperature conditions under which species exist in nature, an indirect method of determining the optimal range of temperatures for successful reproduction of a given species is outlined. The method is applied to bivalve molluscs of the northwestern part of the Pacific Ocean. It is based on the range between summer temperatures in the northern extreme of the geographical distribution and winter temperatures in the southern extreme of the geographic distribution. Changes in survival and optimal temperatures within different biogeographical groups of bivalves were related to changes in geographical zones of their distribution. (ST)

<359>
Schubel, J.R., C.C. Coutant, and P.M.J. Woodhead, State University of New York, Marine Sciences Research Center, Stony Brook, NY; Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN

Thermal Effects of Entrainment.
In Power Plant Entrainment: A Biological Assessment, Chapter 2, J.R. Schubel and B.C. Marcy, Jr. (Eds.). Academic Press, New York, (pp. 19-93), 271 pp. (1978)

As part of an assessment of the effects of entrainment by power plants with once-through cooling systems, criteria for site selection, plant design, and operation were developed to minimize the mortality of entrained organisms associated with thermal stress. The authors critically reviewed the literature on laboratory and field studies and assessed the effects of the thermal stresses experienced by entrained organisms. To minimize mortalities of entrained organisms resulting from thermal stresses, power plants with once-through cooling should use the lowest delta T that is technologically practicable, minimize transit time through the plant's cooling system, and discharge the cooling water in such a way as to promote rapid mixing. However, since the effects upon mortality of the physical stresses experienced during entrainment may be greater than the effects of the thermal stresses, some researchers suggest that power plants should operate at the highest delta T that is biologically acceptable. Recommendations for biological research and power plant design and siting are given. (ST)

<360>
Scott, A.P., and S.M. Baynes, MAFF Fisheries Laboratory, Lowestoft, Great Britain

Effect of Algal Diet and Temperature on the Biochemical Composition of the Rotifer, BRACHIONUS PLICATILIS.
Aquaculture, 14, 247-260 (1978)

Rotifers were fed on four species of algae at a range of temperatures. Growth rate increased with increasing temperature from 10 to 20 C. The type of algae used had little affect on the growth rate. Lipid and carbohydrate composition of the rotifers were generally higher in cultures held at 10 C than in those held at 23 C. (ST)

<361>
Scott, G.I., and D.P. Middaugh, U.S.E.P.A., Gulf Breeze Environmental Research Laboratory, Bears Bluff Field Station, Johns Island, SC; Belle W. Baruch Institute for Marine Biology and Coastal Research, University of South Carolina, Columbia, SC

Seasonal Chronic Toxicity of Chlorination to the American Oyster, CRASSOSTREA VIRGINICA (G).
Conf-771070; In Water Chlorination: Environmental Impact and Health Effects, Volume 2, R.L. Jolley et al. (Eds.), Proceedings of the Second Conference on the Environmental Impact of Water Chlorination, Gatlinburg, TN, October 31-November 4, 1977. Ann Arbor Science, Ann Arbor, MI (pp. 311-328), 909 pp. (1977; 1978)

Three series of continuous flow bioassays were conducted on American oysters (CRASSOSTREA VIRGINICA) to determine seasonal changes in the toxicity of chlorinated seawater. Exposures were for 45 d in the fall (mean temperature 17.5 C, range 10.5-27.0 C), 75 d in the winter (11.2 C, range 4.0-20.0 C) and 60 d in the spring (27.0 C, range 20.5 - 31.5 C). Nominal sodium hypochlorite concentrations were 1.00, 1.80, 3.20 and 5.60 mg/l. Residual oxidants (CPO), measured by amperometric titration every 2-3 d, varied considerably from season to season at each nominal concentration. Mean CPO values were about 12-45% of applied doses. At the highest concentration tested, 50% mortality occurred in 12 d in the fall (CPO 0.98-3.26 mg/l, mean 1.58 mg/l) in 35 d in the spring (CPO 0.75-3.82/l, mean 1.81 mg/l) and in about 35 d in the winter (CPO 2.02-4.95 mg/l, mean 2.98 mg/l). The authors attributed the higher survival of oysters during the winter bioassay to reduced activity and shell closure brought about by extremely low water temperatures (less than 5 C), as well as due to a possible reduction in toxic effect with decreasing temperature. (DHO)

<362>
Seegert, G.L., and A.S. Brooks, University of Wisconsin-Milwaukee, Department of Zoology and Center for Great Lake Studies, Milwaukee, WI

The Effects of Intermittent Chlorination on Coho Salmon, Alewife, Spottail Shiner, and Rainbow Smelt.
Trans. Amer. Fish. Soc., 107, 346-353 (1978)

Coho salmon (ONCORHYNCHUS KISUTCH), alewife (ALOSA PSEUDOHARENGUS), spottail shiner (NOTROPIS HUDSONIUS), and rainbow smelt (OSMERUS MORDAX) were exposed for 30 min to residual chlorine. The alewives were tested at 10, 15, 20, 25, and 30 C, the salmon and shiners at 10, 15, and 20 C and the smelt at 10 C. Thirty-minute LC50 values were both species- and temperature-dependent. All species showed an inverse relationship

<362> CONT.
between test temperatures and LC50 values. The range of LC50 values observed, with the test temperatures in parentheses, were coho salmon, 0.29 (20 C) to 0.56 mg/liter (10 C); alewife, 0.30 (30 C) to 2.27 mg/liter (15 C); spottail shiner, 0.53 (20 C) to 2.41 mg/liter (10 C); and smelt, 1.27 mg/liter (10 C). Mortalities usually occurred within 24 h after exposure. Except for the 10 C spottail shiners, fish rarely recovered following loss of equilibrium. Concentrations resulting in no mortality were approximately 0.6 to 0.7 of the LC50 value. (Auth)

<363>
Senius, K.E.O., Christian Albrecht University, Department of Zoology, Kiel, West Germany; University of Tampere, Department of Biomedical Sciences, Tampere, Finland

Thermal Resistance of the Ciliary Activity in the Gills of the Fresh Water Mussel ANODONTA ANATINA.
Jour. Thermal Biol., 2, 233-238 (1977)

The thermal resistance of the activity of frontal cilia in the median gills of the freshwater mussel ANODONTA ANATINA was studied. The resistance acclimation appeared in two days in the gills of intact animals, but not in isolated gills kept at 4, 14, and 24 C for between one and three days. Warm-acclimation increased the acetylcholine (ACh) sensitivity of the gills of intact mussels. Isolation of the gills enhanced the thermal resistance. ACh, choline and tetramethylammonium enhanced the thermal resistance in the isolated gills, whereas atropine and physostigmine diminished it. It is concluded that in A. ANATINA the control of the thermal resistance is probably neural. (Auth)

<364>
Sheader, M., University of Southampton, Department of Oceanography, Southampton, England

Distribution and Reproductive Biology of COROPHIUM INSIDIOSUM (Amphipoda) on the North-East Coast of England.
Jour. Mar. Biol. Ass. U.K., 58, 585-596 (1978)

The distribution of COROPHIUM INSIDIOSUM AND C. BONNELLII on the coast of Northumberland and Tyne and Wear (England) is described, together with details of the reproductive biology and life-cycle of C. INSIDIOSUM on a fully marine coast at Cullercoats. The duration of marsupial development of C. INSIDIOSUM, from the time of laying to release from the marsupium was followed in the laboratory. At a temperature of 5 C, approximately equivalent to the minimum inshore winter temperature, the duration of development averaged 39 days, whereas at 15 C, equivalent to the summer high temperature, the duration of development averaged only 11 days. During the colder months of the year, if eggs are produced at each molt and fertilization is largely restricted to the time of spring tides, an individual COROPHIUM will produce a brood at every third spring tide, while during the warmer months of the year a brood will be produced by an individual at each period of spring tides. (MU)

<365>
Sherman, L.A., University of Missouri, Division of Biological Sciences, Columbia, MO

Differences in Photosynthesis-Associated Properties of the Bluegreen Alga SYNECHOCOCCUS CEDRORUM Grown at 30 and 40 C.

<362>
Jour. Phycol., 14, 427-433 (1978)

Growth of SYNECHOCOCCUS CEDRORUM at 40 C resulted in structural and functional alterations relative to cells grown at 30 C. Temperature related variations included cell size, membrane proteins, membrane fatty acids, pigment content, photosynthetic capacity, and fluorescence properties. It is suggested that the fatty acid changes at 40 C yield a more fluid membrane which is responsible for the functional alterations. (ST)

<366>
Siefker, C.C., J.N. Cather, and M.D. Blankespoor, University of Michigan, Division of Biological Sciences, Ann Arbor, MI

Tolerance of BIOMPHALARIA GLABRATA Embryos to Continuous Thermal Stress.
Malacological Rev., 10, 31-36 (1977)

Nearly 10,000 embryos of BIOMPHALARIA GLABRATA were continuously subjected to temperatures ranging from 25 to 39 C. Temperatures below 35 C appeared to have no adverse effect on the development of pre-gastrula and post-gastrula snails. However, at higher temperatures, snails developed abnormalities early. At 35 C, approximately 83 hours and 100 hours of exposure were necessary to prevent hatching in pre- and post-gastrula embryos, respectively. (Auth)

<367>
Siegmund, B., and J. Vogel, Sektion Biologie der Humboldt-Universitat, Berlin, German Democratic Republic

The Dependence of Heart Rate and Locomotor Activity on Water Temperature in the Carp (CYPRINUS CARPIO L.).
Experientia (Switz.), 33/12, 1607-1609 (1977)

Measurements of locomotor activity and heart rate of one year old carp were made under different temperature conditions. Both were positively correlated with water temperatures. As water temperature was lowered from 20 to 15 C, heart frequency and locomotor activity decreased by approximately 30 and 50% respectively. Both parameters reached their initial values after the water temperature was raised. A circadian rhythm of swimming activity continued under the different temperature conditions. (ST)

<368>
Siler, J.R., University of Georgia, Athens, GA

The Distribution of Fishes in Two Cooling Reservoirs with Different Heat Loads.
M.S. Thesis (1975)

The effects of thermal loading on certain aspects of the life history and distribution of fishes in Par Pond and Pond C, two cooling reservoirs on the Savannah River Plant, were investigated. Water temperature was an important factor in influencing bass distribution in both reservoirs, but was the controlling factor in the warmest pond, Pond C. Distribution of food organisms appeared to be the most important factor influencing distribution of bass in Par Pond. Largemouth bass were caught at temperatures as high as 36 and 39 C in Par Pond and Pond C, respectively. Gonad development and spawning were correlated with water temperature in both reservoirs. Temperature as well as food availability and population density contributed to low condition factors. Despite the stresses of Pond C, growth of bass was unusually high, with

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<368> CONT.
greatest growth during periods of coolest temperatures. Water temperature was the major factor influencing bluegill distribution in Pond C while distribution of food organisms was most important in Par Pond. Bluegill were caught in anoxic hypolimnetic water where they were feeding on CHAOBORUS. Bluegill concentrated at the Par Pond discharge during summer. Adult bluegill were caught at temperatures as high as 35.5 C in Par Pond and 39 C in Pond C. Immature bluegill were observed at water temperatures as high as 43 C. Lake chubsuckers and flat bullheads were abundant in Par Pond but relatively low in numbers in Pond C. The maximum temperatures at which lake chubsuckers were caught was 32 C in Par Pond and 36 C in Pond C. The maximum temperature at which flat bullheads were caught was 32 C in both Par Pond and Pond C. The distribution of yellow bullhead, black crappie, gizzard shad, mosquitofish, blueback herring, brook silversides, golden shiners, redbreast sunfish, yellow perch, chain pickerel, and warmouth were also given. Differences in water temperature from year to year and therefore changes in the homeostasis of the water system are pointed out. (ST)

<369>
Simpson, T.L., University of Hartford, Department of Biology, West Hartford, CT

The Biology of the Marine Sponge MICROCIONA PROLIFERA (Ellis and Solander). III. Spicule Secretion and the Effect of Temperature on Spicule Size.
Jour. Exp. Mar. Biol. Ecol. (Neth.), 35, 31-42 (1978)

Genetically and physiologically equivalent explants of MICROCIONA PROLIFERA were grown at 15, 20, and 25 C for four weeks. Analyses of spicule dimensions showed little correlation of temperature with spicule length, but there was a clear inverse relationship of spicule width with temperature. It is suggested that thicker spicules are formed at lower temperatures due to the more efficient entrapment of silicon at these temperatures. (ST)

<370>
Sivalingam, P.M., University Sains Malaysia, School of Biological Sciences, Pulau Pinang, Malaysia

Aquaculture of the Green Mussel, MYTILUS VIRIDIS Linnaeus, in Malaysia.
Aquaculture, 11, 297-312 (1977)

Spawning of MYTILUS VIRIDIS was induced by subjecting adults to four 20 min temperature pulses between 25 and 35 C in a seawater medium containing 0.2% NH_4OH. Salinity, temperature, and pH tolerance experiments indicated that survival was 50% between 24 and 80 ppt, between 10 and 35 C, and between 3.5 and 9. Optimum levels of these three variables for growth were between 27 and 65 ppt, 26 and 32 C, and 6 and 8.2, respectively. (ST)

<371>
Smith, G.A., L.C. Fitzpatrick, and W.D. Pearson, Geo-Marine, Inc., Richardson, TX; North Texas State University, Department of Biological Sciences and Institute of Applied Sciences, Denton, TX; University of Louisville, Water Resources Laboratory, Louisville, KY

Metabolic Relations to Temperatures in the Copepods DIAPTOMUS DORSALIS and MESOCYCLOPS EDAX from North-Central Texas.
Comp. Biochem. Physiol., 59A, 325-236 (1978)

Oxygen consumption rates of DIAPTOMUS DORSALIS and MESOCYCLOPS EDAX were determined at 10, 15, 25, and 30 C. Rates increased significantly with temperature in both species, but Q10s indicated that both had slight metabolic compensation to temperature within the 10 to 30 C range, especially between 25 and 30 C. Rates of D. DORSALIS were lower than published rates of congeners from northern populations at similar temperatures. (Auth)

<372>
Somero, G.N., T.J. Chow, P.H. Yancey, and C.B. Snyder, Scripps Institution of Oceanography, La Jolla, CA

Lead Accumulation Rates in Tissues of the Estuarine Teleost Fish, GILLICHTHYS MIRABILIS: Salinity and Temperature Effects.
Arch. Environ. Contam. Tox., 6, 337-348 (1977)

Tissue-specific lead accumulation rates were determined in the estuarine teleost fish, GILLICHTHYS MIRABILIS, as a function of four variables: sea water lead concentration, duration of exposure to lead, salinity, and temperature. Distinct tissue-specific accumulation rates were found. Spleen, gills, fins, and intestine accumulated the greatest amounts of lead; liver and muscle accumulated the least lead. Decay of lead from tissues of lead-exposed fish was observed only for gills, fins, and intestine, tissues which all possess an outer or inner covering of mucus. Our data suggest that the rapid turnover of lead in these mucus-covered tissues is a result of lead complexing with mucus and subsequent loss of lead when the mucus layer is sloughed off. In spleen and vertebrae, lead levels continued to rise in fish returned to natural (unspiked) sea water from lead-spiked sea water. The rate of lead accumulation was dependent on both the holding salinity and the temperature. Fish held at high temperature accumulated lead more rapidly than fish held at low temperature. The rate of lead accumulation was inversely proportional to the salinity of the medium. Both of these environmental effects on lead accumulation rates could be significant in estuarine habitats where lead concentrations, salinity, and temperature are all apt to vary seasonally. (Auth)

<373>
Spence, D.H.N., and H.M. Dale, University of Guelph, Department of Botany and Genetics, Ontario, Canada

Variations in the Shallow Water Form of POTAMOGETON RICHARDSONII Induced by Some Environmental Factors.
Freshwater Biol., 8, 251-268 (1978)

Experimental and seasonal field data at Sparrow Lake, Ontario, Canada indicated that maximal internode extension of POTAMOGETON RICHARDSONII took place on young shoots in very low irradiances at temperatures of 9 to 15 C. At temperatures of 15 C and above, growth occurred from new shoots only and leaves were limp and uncurled compared to those grown below 15 C. The number of expanded leaves and shoot extension reached a maximum at 22 C. Mean internode length was greatest at 16 C. At temperatures of 24, 27, and 30 C more than one shoot per offset was produced. In nature, the effects of increasing water temperatures were depressed by increasing irradiances and aging until minimal extension took place in old shoots at mid- to late-summer temperatures and in high irradiances. (ST)

<374>
Spoor, W.A., U.S. EPA, Environmental Research
Laboratory, Duluth, MN

Oxygen Requirements of Embryos and Larvae of the
Largemouth Bass, MICROPTERUS SALMOIDES
(Lacepede).
Jour. Fish Biol., 11, 77-86 (1977)

Starting with the second day after fertilization, largemouth bass embryos and larvae became increasely sensitive to oxygen deficiency until the sixth day of life. On this day few survived exposure to 1 mg O2/l for 3 h at 20 C; many were damaged at 2 mg/l, but not at 2.5. Death was by asphyxiation or by starvation resulting from an apparent inability to close the lower jaw. On the seventh day the larvae became more resistant again, possibly because opercular movement began on that day. At 25 C the effects of reduced oxygen concentration were intensified, and even a concentration of 2.5 mg/l became lethal in 3 h. At 3 mg O2/l and 20 C the normally quiescent yolk-sac larvae became very active and swam vertically to at least 5 or 6 cm above the substrate; 4 and 5 mg/l had this effect at 23-24 C. This behavior could result in losses by predation and displacement from the nest. (Auth)

<375>
Squires, L.E., Brigham Young University, Provo, UT

Algal Response to a Thermal Effluent: Study of a
Power Station on the Provo River, Utah, USA.
Ph.D. Thesis, Brigham Young University, 64 pp.
(1977)

The effect of a thermal effluent on the attached algae of the Provo River, Utah, was studied from 1975 to 1977. Data for macroscopic and microscopic algae were collected and analyzed. Diatoms, CLADOPHORA GLOMERATA, and HYDRURUS FOETIDUS dominated the flora. The thermal effluent significantly affected the algal flora in a section of the river 100 to 135 meters long immediately below the discharge point. CLADOPHORA growth was increased and HYDRURUS was absent in this area. In addition, diatom production was often higher and diversity lower than in the rest of the river. Community structure was unique from all other adjacent areas. Small temperature increases which occurred as effluent and river waters mixed farther downstream were apparently not as important to the algal flora as other environmental factors. (Auth)

<376>
Stasiak, R.H., University of Nebraska at Omaha,
Department of Biology, Omaha, NB

Reproduction, Age, and Growth of the Finescale
Dace, CHROSOMUS NEOGAEUS, in Minnesota.
Trans. Amer. Fish. Soc., 107, 720-723 (1978)

The life history of the finescale dace, CHROSOMUS NEOGAEUS, was studied in Itasca State Park, Minnesota, during 1969 to 1971. The breeding season began in late April, reached a peak in early May, and was essentially completed by the end of May. Water temperature in the pond varied between 11 and 19 C during late April and early May; spawning activity took place at temperatures above 15 C. Water-hardened eggs that had been manually stripped and fertilized in the laboratory averaged 1.4 mm in diameter; they hatched in 6 days at 20 C. (MU)

<377>
Stefano, G.B., E.J. Catapane, and J.M. Stefano,
Fordham University, Department of Biological
Sciences, Bronx, NY

<374>

Temperature Dependent Ciliary Rhythmicity in
MYTILUS EDULIS and the Effects of
Monoaminergic Agents on Its Manifestation.
Biol. Bull., 153, 618-629 (1977)

Lateral ciliary activity of the bivalve mollusc MYTILUS EDULIS was studied in the field and in the laboratory. A diurnal rhythm corresponding to the environmental temperature changes was found. This behavior was modified by treating animals with serotonergic and dopaminergic agents, disrupting the serotonin and dopamine innervation of the cilia. The study shows that manifestation of this temperature-dependent rhythmicity is due peripherally and centrally to monoaminergic pathways. (Auth)

<378>
Stefano, G.B., L. Hiripi, and E.J. Catapane, The
East Coast Neuroscience Foundation, Inc.,
NY; New York City Community College,
Department of Biological Sciences, Brooklyn,
NY; Biological Research Institute, Tilhany,
Hungary; Medgar Evers College, Department of
Natural Sciences, Brooklyn, NY

The Effects of Short and Long Term Temperature
Stress on Serotonin, Dopamine and
Norepinephrine Concentrations in Molluscan
Ganglia.
Jour. Thermal Biol., 3, 79-83 (1978)

Groups of MYTILUS EDULIS and ANODONTA CYGNEA were acclimated to either cold (5 C) or warm (17 or 20 C) temperatures for 30 days and then subjected to the following temperatures (5, 17 or 20, 28 C) for up to 21 days. Serotonin, dopamine and norepinephrine concentrations of the CNS were determined spectrofluorometrically at various time intervals during the stress. For both species heat stress increased serotonin and cold stress decreased it. The catecholamines showed transient cyclic changes for both treatments. Monoamine levels in these species are quickly altered by temperature stress and the changes can be long lasting. (Auth)

<379>
Stern, S., and Y. Achituv, The Hebrew University
of Jerusalem, Department of Zoology,
Jerusalem, Israel

Effects of Temperature and Salinity on the
Metabolism and Byssal Formation of
BRACHIDONTES VARIABILIS Krauss (Bivalvia).
Comp. Biochem. Physiol., 59A, 101-105 (1978)

The effects of temperature and salinity on BRACHIDONTES VARIABILIS were studied. Increase in temperature from 27 to 33 C resulted in a net decrease in oxygen uptake. Salinity increments from 47 to 58 ppt resulted in a decrease in oxygen uptake with an apparent stabilization indicating adaptation. Combined increases in temperature and salinity resulted in initial fluctuations in oxygen uptake (either overshoot or undershoot), followed by a return to the pretest rate of oxygen uptake. Nitrogen excretion increased in most of the experiments indicating enhanced utilization of proteins. Correlation was found between byssal formation (percentage of animals forming byssus) and the degree of stress imposed on the animals. Mortality and survival were modified by the salinity regime imposed. Thermal tolerance significantly increased in high salinities. It is suggested that the osmoconforming ability of B. VARIABILIS is responsible for such a relationship. The metabolic plasticity of B. VARIABILIS as expressed in this study is believed to have played a

<379>
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major role in its ability to migrate into the Mediterrancean Sea. (Auth)

<380>
Stevens, A.R., R.L. Tyndall, C.C. Coutant, and E. Willaert, Veterans Administration Hospital, Research Service, and University of Florida, College of Medicine, Gainesville, FL; Oak Ridge National Laboratory, Biology and Environmental Sciences Divisions, Oak Ridge, TN; Institute of Tropical Medicine, Department of Protozoology, Antwerp, Belgium

Isolation of the Etiological Agent of Primary Amoebic Meningoencephalitis from Artificially Heated Waters.
Appl. Environ. Microbiol., 34, 701-705 (1977)

To determine whether artificial heating of water by power plant discharges facilitates proliferation of the pathogenic free-living amoebae that cause primary amoebic meningoencephalitis, water samples (250 ml) were taken from discharges within 3,000 feet (ca. 914.4 m) of power plants and were processed for amoeba culture. Pathogenic NAEGLERIA FOWLERI grew out of water samples from two of five lakes and rivers in Florida and from one of eight man-made lakes in Texas. Pathogenic N. FOWLERI did not grow from water samples taken from cooling towers and control lakes, the latter of which had no associated power plants. The identification of N. FOWLERI was confirmed by pathogenicity in mice and by indirect immunofluorescence analyses, by using a specific antiserum. (Auth)

<381>
Stevens, D.E., and B.J. Finlayson, California Department of Fish and Game, Bay-Delta Fishery Project, Stockton, CA; California Department of Fish and Game, Fish and Wildlife Water Pollution Control Laboratory, Rancho Cordova, CA

Mortality of Young Striped Bass Entrained at Two Power Plants in the Sacramento-San Joaquin Delta, California.
In Fourth National Workshop on Entrainment and Impingement, L.D. Jensen (Ed.). EA Communications, Melville, NY, (pp. 57-69), 424 pp. (1978)

Mortalities were estimated for young striped bass approximately 8 to 31 mm long entrained in cooling waters of the Pittsburg and Contra Costa power plants. These estimates were based on catches of live and dead bass at the power plant discharges and intakes. Mortality increased linearly up to 100% with (1) discharge temperatures starting at about 31 C and increasing to about 38 C, and (2) temperature increases of 7 or 8 C to 17 C above ambient river temperature. TL50s were 33.9 C and 12.3 C. Estimates of mortality caused by mechanical stresses were quite variable. Mean estimates were 10.8% and 13.8% for the two analyses presented here. (Auth)

<382>
Stolbov, A.Ya., and Yu.S. Alikin, Institute of Physiology, Siberian Department, Novosibirsk, USSR

Temperature Dependence of Active Metabolism and Swimming Speed of the Baikal Grayling, THYMALLUS ARCTICUS BAICALENSIS.
Jour. Ichthyol., 17, 178-179 (1977)

The influence of temperature on oxygen consumption of the Baikal grayling was investigated under conditions of rest and at different speeds of swimming. Standard metabolism had a Q10 of 2. An increase in temperature from 4 to 12 C increased oxygen consumption by 75%. During swimming the absolute increase in oxygen consumption (compared with standard metabolism) depended only on the speed of swimming and not on the temperature. (ST)

<383>
Stromgren, T., University of Trondheim, Royal Norwegian Society of Sciences and Letters, The Museum, Trondheim, Norway

Short-Term Effects of Temperature upon the Growth of Intertidal Fucales.
Jour. Exp. Mar. Biol. Ecol. (Neth.), 29, 181-195 (1977)

The growth rate of five species of intertidal Fucales (PELVETIA CANALICULATA, FUCUS SPIRALIS, FUCUS VESICULOSUS, FUCUS SERRATUS, and ASCOPHYLLUM NODOSUM) was measured at temperatures from 2.5 to 35 C. An increase in temperature immediately caused a high growth rate, and during the first hour it increased linearly with temperature; at 35 C it was 20 times the control at 7 C. This acceleration of growth was based mainly on stored photosynthate. After the first few hours the growth rate decreased rapidly, particularly at the highest temperatures. After 2 to 3 weeks a temperature optimum below 17.5 C was indicated. High temperatures, 30 to 35 C, were lethal to all species, with a survival time corresponding to their vertical zonation in the natural habitat. (Auth)

<384>
Stuart, T.J., and J.A. Stanford, North Texas State University, Department of Biological Sciences, Denton, TX

A Case of Thermal Pollution Limited Primary Productivity in a Southwestern U.S.A. Reservoir.
Hydrobiologia (Den.), 58, 199-211 (1978)

North Lake, a small (330 ha. surface area) southwestern U.S.A. cooling water reservoir was found to contain less phytoplankton production (104.0 mg C m-3 day-1), lower annual mean total organic carbon (3.7 mg l-1) and phytoplankton standing crops (0.9 ml m-3) than other local area reservoirs. Concentrations of inorganic P and N were at or below test detection limits during the study year 1973-1974. In situ C14 non-filtration primary productivity techniques demonstrated significant (=13 percent) stimulation of planktonic primary productivity due to power plant entrainment. Optical counts showed no destruction of entrained phytoplankters. Populations of Cyanophyta were never dominant, although they frequently bloom in most other local reservoirs. Thermal loading at North Lake is thought to ultimately depress phytoplankton primary production and standing crop by causing nutrient limitation. (Auth)

<385>
Suffern, J.S., S.M. Adams, B.G. Blaylock, C.C. Coutant, and C.A. Guthrie, Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN

Growth of Monosex Hybrid Tilapia in the Laboratory and Sewage Oxidation Ponds.
In R.O. Smitherman et al. (Eds).), Symposium on Culture of Exotic Fishes, Fish Culture Section, Amer. Fish. Soc., Alburn, AL (1978)

Studies were conducted to evaluate the potential of monosex hybrid tilapia (female TILAPIA MOSSAMBICA x male TILAPIA HORNORUM) in waste-heat polyculture systems. The

<385> CONT.

optimum growth temperature for this hybrid was found to be 32 C in laboratory experiments. Experiments in sewage pond cage culture in the temperature range of 23-33 C at stocking densities of approximately 53 fish/m3 were also conducted. At fish sizes between 5 and 12 cm TL, estimated annual production is approximately 50,000 kg/ha/yr (50,000 lb/acre/yr). Fish grown in the sewage oxidation ponds grew significantly faster than fish fed trout chow at optimum temperature in the laboratory, even though temperatures in the sewage ponds averaged below the optimum growth temperature. Techniques to accelerate growth rates are being explored. Exposure to gamma radiation (500 rads), known to cause significant increases in channel catfish growth rate, was found to have a similar effect on tilapia. After a 20-week growth period, exposed fish averaged 20% heavier than controls. (Auth)

<386>
Sullivan, J.K., University of Tasmania,
Department of Physics, Hobart, Tasmania

Effects of Salinity and Temperature on the Acute Toxicity of Cadmium to the Estuarine Crab PARAGRAPSUS GAIMARDII (Milne Edwards).
Australian Jour. Mar. Freshwater Res., 28, 739-743 (1977)

In static acute toxicity tests on the crab PARAGRAPSUS GAIMARDII, the cadmium chloride concentrations fatal to 50% of the test animals over 96 h were determined for temperatures of 5 and 19 C and salinities of 8.6, 17.5, 26.3 and 34.6 g/l. The LC-50 values ranged from 15.7 to 101.9 mg Cd(+2)/l. The mortality was greater at the higher temperature but at both temperatures a decrease in salinity caused an increase in the lethality of cadmium for the crabs. (Auth)

<387>
Sutherland, J.W., State University of New York,
Albany, NY

Environmental Regulation of the Diapause Interval and Diapause Termination in the Dicyclic and the Spring Monocyclid Patterns of DAPHNIA PULEX: A Basis for the Distinction Between Different Seasonal Patterns.
Ph.D. Thesis, State University of New York, 230 pp. (1978)

Some populations of the cladoceran DAPHNIA PULEX produce diapausing embryos in the spring only (spring monocycle), others in the autumn only (autumn monocycle), and others during both spring and autumn (dicycle). This investigation attempted to determine if the dicyclic and monocyclic patterns are environmentally or genetically controlled. Cloned and uncloned cultures representing the two seasonal patterns were maintained at 3, 7.5, 11, and 21 C and exposed to short daylength, long daylength or a combination of the two. Temperature and daylength influenced completion of the refractory phase, and temperature influenced duration of the refactory phase. It was concluded that the distinction between the dicyclic and spring monocyclic populations tested in this investigation was based upon genetic control of the diapause interval and diapause termination. (NU)

<388>
Sweeney, B.W., University of Pennsylvania,
Department of Biology, Philadelphia, PA;
Academy of Natural Sciences of Philadelphia,
Philadelphia, PA

<385>

Bioenergetic and Developmental Response of a Mayfly to Thermal Variation.
Limnol. & Oceanog., 23, 461-477 (1978)

Egg development, growth, and emergence of ISONYCHIA BICOLOR were observed in White Clay Creek (PA) at ambient temperatures and in fluctuating experimental regimes with diel minima ranging from 12 to 12.9 C and maxima between 12 and 20.1 C. Development rate of both eggs and nymphs was correlated positively with increased magnitude of the diel temperature pulse. Adult metamorphosis was most successful in regimes with diel maxima greater than 16 C. Subimago body size and fecundity for winter generation females were about double those for the summer generation. Reducing spring and summer water temperatures lowered the fecundity of winter and summer subimagoes. Weight-specific respiration rates of nymphs measured at 14 constant temperatures (range, 1 to 21 C) increased with temperature but were inversely related to body size at a given temperature. Metabolic response to short term (1 h) changes in temperature was immediate; thermal acclimation or compensation was not observed. Energy budgets were calculated for male and female nymphs reared in various thermal regimes. Growth rates, net growth efficiencies, and production:respiration ratios of female nymphs were about twice those of males at all temperatures. Overall net growth efficiencies for I. BICOLOR averaged 44.16% and P:R ratios 0.84 for the combined sexes. (Auth)

<389>
Sweeney, B.W., and R.L. Vannote, Academy of
Natural Sciences of Philadelphia, Stroud
Water Research Center, Avondale, PA

Size Variation and the Distribution of Hemimetabolous Aquatic Insects: Two Thermal Equilibrium Hypotheses.
Science, 200, 444-446 (1978)

Adult body size and fecundity of a number of hemimetabolous aquatic insects depended largely on thermal conditions during the larval period. Small adults and reduced fecundity resulted when temperatures were either warmed or cooled with respect to more optimal thermal conditions. Temperature apparently affected adult size by altering the larval growth rate and the timing and rate of adult tissue development for each larva. The data suggest a new interpretation for the geographic distribution of aquatic insects. (Auth)

<390>
Takamatsu, K., and H. Tsukuda, Osaka City
University, Department of Biology, Osaka,
Japan

Effects of Acclimation Temperature on the Temperature Dependence of Gliding Rate in the Planarian, DUGESIA JAPONICA.
Annot. Zool. Jap., 50, 63-69 (1977)

Planarians of an asexual strain, DUGESIA JAPONICA, were acclimated to 13, 18, and 23 C, respectively and gliding rate was determined at various temperatures on three kinds of bodies; whole animal and anterior and posterior halves. The gliding rate-temperature curve of the whole animals shifted toward higher temperature with rising acclimation temperature. Such acclimational effect was also found in the gliding rate of anterior and posterior halves, although the movement of posterior halves was very slow. This fact suggests that capacity adaptation in the gliding movement is not due to the direct effect

<390>
<390> CONT.
through control systems. (Auth)

<391>
Talmage, S.S., Oak Ridge National Laboratory,
Ecological Sciences Information Center,
Information Center Complex, Oak Ridge, TN

Thermal Effects on Aquatic Organisms -- An Annotated Bibliography of the 1977 Literature.
ORNL/EIS-143, 179 pp. (1978)

This bibliography, containing 537 references from the 1977 literature, is the seventh in a series of annotated bibliographies on the effects of heat on aquatic organisms. The effects of thermal discharges at power plant sites are emphasized. Laboratory and field studies on temperature tolerance and the effects of temperature changes on reproduction, development, growth, distribution, physiology, and sensitivity to other stresses are included. References in the bibliography are divided into three subject categories: marine systems, freshwater systems, and estuaries. The references are arranged alphabetically by first author. Indexes are provided for author, keywords, subject category, geographic location of the study, taxon, and title (alphabetical listing of keywords-in-context of nontrivial words in the title). (Auth)

<392>
Talmage, S.S., Oak Ridge National Laboratory,
Information Division, Oak Ridge, TN

Thermal Effects on Aquatic Organisms - An Annotated Bibliography of the 1976 Literature.
ORNL/EIS-124, 289 pp. (1978)

This bibliography, containing 784 annotated references on the effects of temperature on aquatic organisms, is part of an assessment of the literature on the effects of thermal power plants on the environment. The effects of thermal discharges at power plant sites are emphasized. Laboratory and field studies on temperature tolerance and the effects of temperature changes on reproduction, development, growth, distribution, physiology, and sensitivity to other stresses are included. Indexes are provided for author, keywords, subject category, geographic location of the study, taxon, and title (alphabetical listing of keywords-in-context of nontrivial words in the title). (Auth)

<393>
Talmage, S.S., and C.C. Coutant, Oak Ridge
National Laboratory, Oak Ridge, TN

Thermal Effects.
Jour. Water Poll. Control Fed., 50, 1514-1553 (1978)

The article reviews 371 references from the 1977 literature concerning the effects of temperature on aquatic organisms. References are categorized under the headings reviews and models; site studies; producers; consumer reproduction, development, morphology, distribution, temperature tolerance, oxygen metabolism, growth, feeding, reaction to combined stresses, temperature selection and thermoregulation, activity, and predator-prey relations; decomposers; diseases and parasites; and beneficial uses of waste heat. (ST)

<394>
Tarby, M.J., Cornell University, Ithaca, NY

Energetics and Growth of Walleye (STIZOSTEDION VITREUM VITREUM) in Oneida Lake, New York.
Ph.D. Thesis, Cornell University, 120 pp. (1977)

To gain insight into mechanisms underlying patterns of growth of walleye (STIZOSTEDION VITREUM VITREUM) in Oneida Lake, an investigation was undertaken to delineate requisite energetics. Energy expended by walleye for metabolism was determined in the laboratory by measuring oxygen consumption in respirometers. Standard metabolism was estimated from rate of oxygen consumption of unfed resting fish of various weights for a range of temperatures and a multiple regression equation was developed for prediction. Walleye growth in weight varied tremendously from 1971 to 75, and generally reflected differences observed in daily rations. Construction of an energy budget for 1973 to 75 revealed that levels of walleye metabolism averaged over three times standard, but values varied widely. Apparent low energy return for energy expenditure may explain in part slow growth of walleye in Oneida Lake relative to that reported for walleye in Lake Erie. (Auth) (MU)

<395>
Targett, T.E., University of Maine, Department of
Zoology, Orono, ME

Respiratory Metabolism of Temperature Acclimated FUNDULUS HETEROCLITUS (L.): Zones of Compensation and Dependence.
Jour. Exp. Mar. Biol. Ecol. (Neth.), 32, 197-206 (1978)

The oxygen consumption of temperature acclimated mummichogs, FUNDULUS HETEROCLITUS (L.) weighing 0.1 to 10.0 g, was measured at 5, 13, 21, and 29 C. Between 13 and 21 C and 21 and 29 C, the values of Q10 were 1.55 and 1.04, respectively, indicating relative thermal independence of respiratory metabolic rate over this 16 C range (Q10=1.27). This range encompasses the normal late spring, summer, and early fall range of habitat temperature in Maine estuaries, so that mummichogs are able to grow and reproduce relatively independent of environmental temperature. Between 5 and 13 C, respiratory metabolism is very temperature sensitive (Q10=4.42) indicating a substantial reduction of metabolic processes at low temperatures. This enables mummichogs to conserve any metabolic reserves during the coldest months. The regression of log weight-specific oxygen consumption on log body weight was determined at each experimental temperature. All had significantly negative slopes indicating the importance of body size in mummichog respiration. (Auth)

<396>
Taylor, E.W., P.J. Butler, and A. Al-Wassia,
University of Birmingham, Department of
Zoology and Comparative Physiology,
Birmingham, England

Some Responses of the Shore Crab, CARCINUS MAENAS (L.) TO Progressive Hypoxia at Different Acclimation Temperatures and Salinities.
Jour. Comp. Physiol., 122, 391-402 (1977)

The dual effects of a range of acclimation temperatures and exposure to dilute seawater on the emersion response and on the patterns of respiration of the shore crab during exposure to progressive hypoxia were measured. The mean oxygen tension at which crabs emerged from shallow seawater during progressive hypoxia, as well as the critical

<396> CONT.

oxygen tension levels for the rate of oxygen consumption and ventilation rate of submerged crabs, increased with acclimation temperature (10 to 18 C) and following exposure to 50% seawater at low temperatures (7 to 14 C). This pattern of variation resembles the changes in relative oxygen demand with temperature and salinity. The critical oxygen tension levels for heart rate increased with acclimation temperature, but were unaffected by dilution. (ST)

<397>

Tennessen, K.J., and S.A. Murray, Tennessee Valley Authority, Water Quality and Ecology Branch, Muscle Shoals, AL

Diel Periodicity in Hatching of EPITHECA CYNOSURA (Say) Eggs (Anisoptera:Corduliidae).
Odonatologica, 7, 59-65 (1978)

Eggs of the dragonfly, EPITHECA CYNOSURA, were cultured under natural and controlled conditions to determine both the diel periodicity in hatching and whether photoperiod and fluctuating temperature regimes (constant 24 C vs fluctuating 20 to 24 C) act as environmental cues. Hatching peaked after the onset of darkness. Temperature did not appear to act as an environmental cue for hatching. (ST)

<398>

Tetik, K., and J. Necas, Czechoslovak Academy of Sciences, Laboratory of Biotechnology, Institute of Microbiology, Trebon, Czechoslovakia

Growth Characteristics of CHLAMYDOMONAS GEITLERI.
Arch. Hydrobiol./Suppl. 51 (Ger.), 164-183 (1977)

Growth and production characteristics were studied on a strain of CHLAMYDOMONAS GEITLERI and their dependence on temperature and irradiance was established. The tested strain grew at temperatures between 4 and 28 C. Satisfactory effects of production were recorded between 15 and 25 C. The optimum irradiance was about 30 W/m2. Overirradiation was tolerated at lower temperatures, but the cells suffered considerably when higher temperatures were applied. The mutual relations of the indexes giving the ratios of three independent growth rate parameters (light absorption, dry weight content, cell number) at various levels of temperature and irradiance showed the morphological and functional changes in the cells under extreme conditions to be demonstrated. (Auth)(MU)

<399>

Thatcher, T.O., Battelle Pacific Northwest Laboratories, Marine Research Labortory, Sequim, WA

The Relative Sensitivity of Pacific Northwest Fishes and Invertebrates to Chlorinated Sea Water.
Conf-771070; In Water Chlorination: Environmental Impact and Health Effects, Volume 2, R.L. Jolley et al. (Eds.), Proceedings of the Second Conference on the Environmental Impact of Water Chlorination, Gatlinburg, TN, October 31-November 4, 1977. Ann Arbor Science, Ann Arbor, MI (pp. 341-350), 909 pp. (1977; 1978)

The chlorine tolerance limits of 15 species of fish and invertebrates were tested under continuous flow conditions. Residual oxidant concentrations were measured by amperometric titration. Eleven species were acclimated to 10 C for several weeks and then tested at 14.8 C (a thermal stress of 5

<396>

C). Pacific herring, pink salmon and mysids were acclimated for only 2 to 3 days at 10 C and coon stripe shrimp were acclimated at 8 C for 2-3 weeks and all were tested at 14.8 C. The 96 h LC50 values were 0.032 mg/l for juvenile coho salmon (ONCORHYNCHUS KISUTCH); greater than 0.023 and less than 0.052 mg/l for juvenile pink salmon (ONCORHYNCHUS GORBUSCHA); greater than 0.038 and less than 0.065 mg/l for juvenile chinook salmon (ONCORHYNCHUS TSHAWYTSCHA); 0.065 mg/l for juvenile Pacific herring (CLUPEA HARENGUS); 0.071 mg/l for juvenile and adult shiner perch (CYMATOGASTER AGGREGATA); 0.073 mg/l for juvenile English sole (PAROPHRYS VETULUS); 0.082 mg/l for juvenile and adult Pacific sand lance (AMMODYTES HEXAPTERUS), 0.090 mg/l for the shrimp PANDALUS GONIURUS; 0.134 mg/l for the shrimp CRANGON NIGRICAUDA; 0.145 mg/l for the amphipod ANONYX sp.; 0.162 mg/l for the mysid NEOMYSIS sp.; 0.167 mg/l for juvenile and adult three spine stickelbacks (GASTEROSTEUS ACULEATUS); 0.178 mg/l for juvenile and adult coon strip shrimp (PANDALUS DANAE); 0.687 mg/l for the amphipod PONTOGENIA sp., and 1.418 mg/l for juvenile and adult shore crabs (HEMIGRAPSUS NUDUS and H. OREGONENSIS). (DMO)

<400>

Thompson, K.W., C. Hubbs, and B.W. Lyons, Texas Parks and Wildlife Department, Division of Inland Fisheries, Austin, TX

Analysis of Potential Environmental Factors, Especially Thermal, Which Would Influence the Survivorship of Exotic Nile Perch if Introduced into Artificially Heated Reservoirs in Texas.
Texas Parks and Wildlife Department Technical Series No. 22, 37 pp. (1977)

In order to control the relative density of rough fishes (DOROSOMA CEPEDIANUM, CYPRINUS CARPIO, ICTIOBUS BUBALIS, and CARPIODES CARPIO) in Texas cooling reservoirs, the introduction of exotic predators is being considered. Several species of the tropical genus LATES, the Nile perches, have been proposed since they would presumably pose no environmental threat due to their probable inability to withstand ambient winter temperatures. The lethal temperatures of three species of LATES were determined by changing the temperature in aquaria 1 C/day until all fish were killed. Lethal limits were 11 and 38 C. Feeding was vigorous between 16 and 35 C; beyond limits of 13 and 36 C no feeding was observed. There were no species differences. Heat and cold shock tests were also performed. (ST)

<401>

Thorhaug, A., N. Blake, and P.B. Schroeder, University of Miami, School of Medicine, Department of Microbiology, Miami, FL; University of South Florida, Department of Marine Science, St. Petersburg, FL

The Effect of Heated Effluents from Power Plants on Seagrass (THALASSIA) Communities Quantitatively Comparing Estuaries in the Subtropics to the Tropics.
Marine Poll. Bull., 9, 181-187 (1978)

The paper synthesizes biological results of studies of four seagrass-dominated estuaries receiving thermal effluents. Guayanilla Bay, Puerto Rico, is located in the central tropics; Biscayne Bay and Card Sound, Florida, are located on the border between tropics and subtropics; and Tampa Bay, Florida, is located in the central subtropics. THALASSIA TESTUDINUM is the dominant plant species at all sites. Temperatures of effluents range from 0.5 to 10 C above ambient, with most at 1 to 5 C

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above ambient. Summer mean temperatures in all three estuaries range around 30 C. Temperatures of +1 and +1.5 were minimally damaging to the studied areas. Insufficient data was available at +2 to make a statement. At +4 C, intense damage to the biological communities at all locations was evident: at +3 C, the effect varied from severe damage in the subtropics to 40% damage in the tropics. Recommended summer heated effluent release for power plants eliminating heat onto THALASSIA beds should not be greater than +3 C. Winter release temperatures could be greater. (ST)

<402>

Thorhaug, A., and M.A. Roessler, University of Miami School of Medicine, Department of Microbiology, Miami, FL; Tropical Bio Industries, Development Company, Miami, FL

Seagrass Community Dynamics in a Subtropical Estuarine Lagoon.
Aquaculture, 12, 253-277 (1977)

The temporal and spatial distribution of major plant and animal species were investigated for four years in south Biscayne Bay including Card Sound, Florida, a subtropical estuarine lagoon. The major species of plants were THALASSIA TESTUDINUM (turtle grass), LAURENCIA POTEI (red macroalgae), and PENICILLUS CAPITATUS and HALIMEDA INCRESSATA (green algae). The major animal species were not equally distributed: near shore, mid-bay, and fringing island groups were identified. Comparisons with other known THALASSIA communities were made. THALASSIA productively was highly dependent on temperature with an optimum growth near 29 C, falling sharply above this temperature, and having a linear correlation below 28 C to about 24 C. (ST)

<403>

Thornton, K.W., and A.S. Lessem, U.S. Army Engineer Waterways Experiment Station, Environmental Effects Laboratory, Vicksburg, MS

A Temperature Algorithm for Modifying Biological Rates.
Trans. Amer. Fish. Soc., 107, 284-287 (1978)

An algorithm for modifying biological rates as a function of temperature was developed using the basic form of the logistic equation. Versions of this algorithm were then used to modify growth, respiration, and mortality rates (for fish) as a function of four characteristic temperatures. (Auth)

<404>

Thorp, J.H., Savannah River Ecology Laboratory, Aiken, SC

Agonistic Behavior of Crayfish in Relation to Temperature and Reproductive Period.
Oecologia (Ger.), 36, 273-280 (1978)

The relationship between temperature and agonistic behavior in the crayfish, CAMBARUS LATIMANUS, a species which is reproductively active in winter was examined. Crayfish were acclimated for two weeks at 9.5, 14, 22, and 30 C in summer and at 9.5 and 22 C in winter. Agonistic behavior of pairs of the same sex was recorded for one hour following acclimation. Contrary to published literature, duration of total agonistic behavior, maximum duration of a single agonistic interaction, and average length of an agonistic encounter were all inversely related to acclimation temperature. It is hypothesized that increased agonistic behavior is directly related to temperature changes which precede the reproductive period. For this species the reproductive period is cued by decreasing temperatures. (Auth) (ST)

<405>

Tirri, R., M. Vormanen, and A.R. Cossins, University of Turku, Department of Zoophysiology, Turku, Finland; University of Liverpool, Department of Zoology, Liverpool, England

The Compensation of ATPase Activities in Brain and Kidney Microsomes from Cold and Warm-Acclimated Carp (CYPRINUS CARPIO L.).
Jour. Thermal Biol., 3, 131-135 (1978)

Temperature acclimation (10 And 20 C) of carp had no effect upon the specific activities or Arrhenius plots of the Mg(+2) ATPase or the Na(+)-K(+) ATPase of their brain microsome preparations. The Na(+)-K(+) ATPase activities of kidney microsomes isolated from 10 C acclimated carp was approximately one-third greater than in kidney microsomes from 20 C acclimated carp. However, Mg(+2) ATPase of 10 C acclimated carp was approximately one-third smaller than in 20 C acclimated carp. (Auth) (ST)

<406>

Tischner, R., K.-P. Heise, R. Nelle, and H. Lorenzen, Pflanzenphysiologisches Institut der Universitat and Lehrstuhl fur Biochemie der Pflanze, Gottingen, W. Germany

Changes in Pigment Content, Lipid Pattern and Ultrastructure of Synchronous CHLORELLA after Heat and Cold Shocks.
Planta (W. Ger.), 139, 29-33 (1978)

Completely synchronous CHLORELLA cultures were treated with heat (45 C) or cold shocks (4 C) of different lengths at the sixth hour of the 14:10h light-dark-cycle. After the treatment the cells were grown under normal conditions. Analysis at the end of the cycle showed a direct connection between pigment bleaching, reduction of lipid content, loss of thylakoid stacking and a shift of the fluorescence emission maximum into a region of shorter wavelength. The thylakoid stacking was completely loosened after a heat shock while two thylakoids remained in contact after cold treatment. This probably explains the different regeneration capacities in temperature shock treated cells. None of the described effects could be observed directly after the shocks. From the parallel decay of chlorophyll a, monogalactosyl diglyceride and carotenoids an intimate correlation with the photosystem II complex is suggested. (Auth)

<407>

Tolksdorf, W., Institute fur Meereskunde an der Universitat Kiel, Germany

The Influence of Salinity and Temperature on Growth, Metabolism and Lethal Temperature of the Sand Goby POMATOSCHISTUS MICROPS K..
Meeresforsch. (Ger.), 26, 15-29 (1977)

Sand gobies (POMATOSCHISTUS MICROPS) were adapted to salinities of 4.5, 9, 13.5, and 18 g/l at 15 and 20 C. Food intake, growth, and metabolism were studied at the acclimation temperatures and the effect of increasing the temperature up to 32 C on the metabolic rate was noted. Upper lethal temperature was determined by further increasing the temperature. At an acclimation temperature of 15 C the lethal temperature increased from 32.6 to 33.5 with

<407> CONT.
increasing salinity. At an acclimation temperature of 20 C the lethal temperature increased from 34.2 to 34.5 under the same conditions. (ST)

<408>
Tomas, C.R., University of Rhode Island, Graduate School of Oceanography, Kingston, RI

OLISTHODISCUS LUTEUS (Chrysophyceae) I. Effects of Salinity and Temperature on Growth, Motility and Survival.
Jour. Phycol., 14, 309-313 (1978)

The effect of salinity and temperature on OLISTHODISCUS LUTEUS Carter was examined to assess the relative importance of these factors on dynamics of natural populations. A salinity range (2 to 50 ppt) was observed with increased tolerance to low salinity (less than 5 ppt) at higher temperatures (20 to 30 C). Cultures at 4 to 5 ppt salinity had densities of 10(E+5) cells/ml, and growth greater than 0.5 division/day at temperatures of 15 to 30 C. At higher salinities (5 to 50 ppt) variable but distinct optima for density, growth, and motility were observed at 5, 10, and 30 C. Density and motility showed no clear optima for 10 to 40 ppt at 15 to 25 C where maximum growth rates greater than 1.0 division/day were common. Temperature increases from 5 to 30 C produced 4-fold increases in growth rate (0.5 to 1.9 divisions/day) and increases of three orders of magnitude for maximum densities. Temperature optima at 20 C for growth at 5 to 35 ppt, and 25 C for greater than 40 ppt were observed.
(Auth)(MU)

<409>
Turczynska, J., and R.J. Wisniewski, Polish Academy of Sciences, Department of Hydrobiology, Institute of Ecology, Lomianki, Poland

Effect of Heated Waters on Biocenosis of the Moderately Polluted Narew River. Phytoplankton.
Pol. Arch. Hydrobiol., 23, 507-518 (1976)

The effect of a power station on phytoplankton was investigated in the moderately polluted Narew River (Poland) between August 1972 and November 1973. Depending on the rate of flow of the river waters, from 20 to 30% of the river flow passed through the cooling system of the power station. The rise of the water temperature in the cooling system averaged 8.7 C. The water temperature in the river downstream was higher by over 2 C and was periodically higher than 28 C in the summer. Until the spring of 1973 bacillariophyceae and cyanophyta were dominant species in the phytoplankton of the examined sector of the Narew River. Passage through the cooling system of the power station at a high velocity did not cause any noticeable changes in the species composition, composition of dominants, density, and biomass of phytoplankton and the pheopigments/chlorophyll a ratio. At a low water level (summer and autumn 1973) an increase of cyanophyta in the total density and biomass of phytoplankton was observed in the sector of the river downstream, directly below the discharge of the cooling waters. In the farther sector of the river, an increase in the density and biomass of cyanophyta was observed in late summer and in autumn 1973, as well as an abundant development of nannoplankton in summer 1973. Changes were presumably caused by the synergistic effect of the heated water and the increased water pollution. (Auth)(MU)

<410>
Tyndall, R.L., E. Willaert, A.R. Stevens, and C.C. Coutant, Oak Ridge National Laboratory, Oak Ridge, TN

Isolation of Pathogenic NAEGLERIA from Artificially Heated Waters.
CONF-770961; In Proc. Symp. Microbiology of Power Plant Thermal Effluents. University of Iowa Press, Iowa City (1978)

Investigations were undertaken to determine whether heated waters faclilitate the proliferation of free-living amoeba that cause primary amoebic meningoencephalitis. Water samples were taken close to the discharges of power plants situated on lakes or rivers in Florida and Texas and from cooling towers in Tennessee. The water temperatures ranged from 29 to 42 C. Water samples were also taken from several lakes in Florida and Texas without associated power plants. The temperatures of these ranged from 30 to 34 C. Samples taken from the control lakes and cooling towers showed no growth of pathogenic amoeba, whereas growth was obtained from 2 of the 8 lakes and rivers in Florida and from 1 of the 7 man-made lakes in Texas that were artifically heated. The amoebae were identified as belonging to the genus NAEGLERIA from their trophozoite and cyst structure, ability to grow at 45 C, to transform into flagellates, and to produce primary amebic meningoencephalitis (PAME) in mice after intranasal instillation. Their identification as N. FOWLERI was confirmed by indirect immunofluorescent analysis with antiserum produced against N. FOWLERI. These findings indicate that artificial heating of waters may facilitate the growth of pathogenic free living amoeba. (Auth)(ST)

<411>
Ultsch, G.R., H. Boschung, and M.J. Ross, University of Alabama, Department of Biology, University, AL

Metabolism, Critical Oxygen Tension, and Habitat Selection in Darters (ETHEOSTOMA).
Ecology, 59, 99-107 (1978)

Interrelationships between oxygen requirements, temperature, and habitat selection in six species of darters were investigated. Metabolic rates were determined after acclimation to winter (10 C) and summer (20 C) temperatures. The critical oxygen tension decreased in five of the six species at 20 C when compared to that at 10 C. Field measurements showed that winter O2 tensions were not limiting to the distribution of darters when compared with critical O2 determinations made in the laboratory at 10 C. However, summer ambient O2 levels were low. The fishes compensated for this by lowering critical oxygen tensions in the summer. (ST)

<412>
Vaidya, D.P., and R. Nagabhushanam, Marathwada University, Department of Zoology, Aurangabad, India

Laboratory Studies on the Direct Effect of Temperature on the Freshwater Vector Snail, INDOPLANORBIS EXUSTUS (Deshyes).
Hydrobiologia (Den.) 61, 267-271 (1978)

The present study includes the effect of temperature on the survival of young and adult snails, embryonic development, embryonic growth and egg laying of INDOPLANORBIS EXUSTUS. In INDOPLANORBIS EXUSTUS, the bottom lethal temperature was 7.0 C and 7.5 C for young and adults respectively, while the upper lethal

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temperature was 34.0 C and 32.0 C, for young and adult snails respectively. Between the temperatures 12.5 C and 36.5 C the embryonic development was accelerated and the incubation period was shortened. The growth of embryos was found to be faster at 25.0 C. The optimum temperature for egg laying was observed at 25.0 C. (Auth)

<413>
Van Dolah, R.F., University of Maryland, College Park, MD

Factors Regulating the Distribution and Population Dynamics of the Amphipod GAMMARUS PALUSTRIS in an Intertidal Salt Marsh Community.
Ph.D. Thesis, University of Maryland (1977)

As part of a study of factors regulating the distribution and population dynamics of GAMMAPUS PALUSTRIS in an intertidal salt marsh, tolerance to low salinity, heat/dessication stress, and freezing temperatures were studied in the laboratory. Comparisons of the results with observed fluctuations of these variables at two study sites, the Patuxent and Rhode rivers, demonstrated that only freezing temperatures would cause significant mortality in intertidal populations of this species. Insufficient tolerance to this stress was postulated as the reason for the observed distributional shift to subtidal areas during the winter. Amphipod distribution within the intertidal zone at other times of the year was highly correlated with SPARTINA density. (ST)

<414>
Venables, B.J., L.C. Fitzpatrick, and W.D. Pearson, Oklahoma State University, School of Biological Sciences, Stillwater, OK; North Texas State University, Department of Biological Sciences and Institute of Applied Sciences, Denton, TX; University of Louisville, Water Resources Laboratory, Louisville, KY

Laboratory Measurement of Preferred Body Temperature of Adult Largemouth Bass (MICROPTERUS SALMOIDES).
Hydrobiologia (Den.), 58, 33-36 (1978)

Preferred deep body temperatures of adult bass were determined in the laboratory using a horizontal temperature gradient and telemetry. The method used allowed continuous monitoring of body temperatures of adult bass in the gradient. The preferred temperature of adults (range = 27-32 C) was similar to preferenda reported earlier for sub-adults. (Auth)

<415>
Venables, B.J., L.C. Fitzpatrick, and W.D. Pearson, North Texas State University, Department of Biological Sciences and Institute of Applied Sciences, Denton, TX; University of Louisville, Water Resources Laboratory, Louisville, KY

Acclimation Temperature and Temperature Tolerance in Fingerling Largemouth Bass (MICROPTERUS SALMOIDES).
Environ. Poll., 17, 161-165 (1978)

Fingerling largemouth bass were acclimated to temperatures ranging from 15 to 35 C (5 C intervals) and tested at temperatures ranging from 10 to 40 C to determine tolerance to rapid temperature changes. Bass were able to survive delta T's as great as 20 C. The 40 C test temperature was immediately lethal for all acclimation groups except the 35 C group which had a mean survival time of 19 min. The 35 C test temperature was immediately lethal to both the 15 and 20 C acclimation groups. The 10 and 15 C test temperatures were lethal to the 35 C acclimation group. (ST)

<416>
Vernberg, F.J., M.S. Guram, and A.M. Savory, Belle W. Baruch Institute for Marine Biology and Coastal Research, University of South Carolina, Columbia, SC; Voorhees College, Department of Biology, Denmark, SC

Metabolic Response to Thermal Changes of the Adult Fiddler Crab UCA PUGILATOR and the Effect of PCBs.
Marine Biol. (W. Ger.), 48, 135-141 (1978)

Data on the influence of sublethal concentrations of Aroclors 1016 and 1254 (50 ppb), together with various combinations of temperature and thermal acclimation, on the respiration of UCA PUGILATOR are presented. At 25 C, the respiration rate of both males and females increased initially after exposure to these Aroclors. After the crabs were returned to uncontaminated seawater, their respiratory rates were similar to initial pre-exposure values. At 15 C, Aroclors 1016 and 1254 had no apparent effect on the respiration of males but depressed that of females. Upon exposure to PCB-free seawater, the metabolic rate of both male and female crabs was similar to initial pre-exposure rates. At 35 C, a trend existed for both of these PCBs to inhibit respiration. In a series of experiments on cold- and warm-acclimated individuals, PCBs did not consistently influence metabolic response over the thermal range of 10 to 30 C. (Auth)(ST)

<417>
Vernberg, F.J., M.S. Guram, and A.M. Savory, University of South Carolina, Belle W. Baruch Institute for Marine Biology and Coastal Research and Department of Biology, Columbia, SC; Voorhees College, Department of Biology, Denmark, SC

Survival of Larval and Adult Fiddler Crabs Exposed to Aroclor 1016 and 1254 and Different Temperature-Salinity Combinations.
In Physiological Responses of Marine Biota to Pollutants, F.J. Vernberg et al. (Eds.). Academic Press, New York, (pp. 37-50) (1977)

The relative influence of the polychlorinated biphenyls Aroclor 1254 and Aroclor 1016 on the survival of larval and adult fiddler crabs (UCA PUGILATOR) was determined under different temperature-salinity combinations. Stress combinations included five experimental temperature (15, 20, 25, 30, and 35 C), five salinities (15, 20, 25, 30, and 35 ppt) and two concentrations of the Aroclors (0.1 and 1.0 ppb). Concentrations of 0.1 and 1 ppb of Aroclors had little or no effect on larval survival. The lethal concentration after 96 hrs exposure at 25 C was approximately 10 ppb. Survival levels for larvae subjected to various concentrations of the Aroclors and for various periods of time were also determined. A concentration of either 0.1 ppb of either Aroclor 1254 or Aroclor 1016 in combination with various combinations of temperature and salinity had little influence on survivorship of one day old larvae. Temperature-salinity combinations that deviated from optima (25 C and 30 ppt) affected larval survival to some degree, but results were variable. Where an effect was detected, Aroclor 1254 was usually more toxic. In the experiments using 1.0 ppb Aroclor, the interaction of temperature and salinity did influence the response, but not all combinations were

<417> CONT.

effective nor were the results always predictable. Of the three temperatures 30 C was the most stressful at the three salinities. Adult fiddler crabs withstood 100 ppb for three weeks. (ST)

<418>

Vernier, J.M., Department of the Environment, Fisheries and Marine Service, Pacific Biological Station, Nanaimo, British Columbia, Canada

Chronological Table of the Embryonic Development of Rainbow Trout, SALMO GAIRDNERI Rich. 1836.

Canada, Fisheries Research Board, Translation Series No. 3913; From Ann. Embryol. Morphog., 2, 495-520 (1969) (1977)

As part of a study of the influence of environmental factors on the embryonic development of salmonid fish, the effects of temperature on development are reviewed. A table of development of SALMO GAIRDNERI from fertilization to absorption of the yolk sac (temperature 10 C) was compiled. Developmental stages are illustrated. (ST)

<419>

Vincent, B., and G. Vaillancourt, Universite du Quebec a Trois-Rivieres, Department Chimie-Biologie, Trois-Riveres, Canada

Benthic Groups in the St. Lawrence River near the Gentilly Power Plants (Quebec).

Can. Jour. Zool., 56, 1585-1592 (1978)

The structure and distribution of the macrobenthos were determined to evaluate the present state of the section of the St. Lawrence River which might be affected by the cooling waters of the Gentilly nuclear reactors. Ten groups were recognized, characterized by the presence of one to three constant and dominant species. In lentic conditions characterized by the presence of the gastropod BITHYNIA TENTACULATA the zonation is depth dependent. Three groups inhabit the littoral zone characterized by the Glossoscolecidae SPARGANOPHILUS TAMESIS. There are two groups in the sublittoral zone characterized by the Tubificidae LIMNODRILUS HOFFMEISTERI and two groups in the deep waters characterized by the Sphaeriidae SPHAERIUM STRIATINUM. BITHYNIA TENTACULATA, a hydrobiid, seldom inhibits the lotic environment where the Tubificidae LIMNODRILUS HOFFMEISTERI is the only typical species. (Auth)

<420>

Vlasblom, A.G., and J.H.B.W. Elgershuizen, Delta Institute of Hydrobiological Research, Yerseke, The Netherlands

Survival and Oxygen Consumption of PRAUNUS FLEXUOSUS and NEOMYSIS INTEGER, and Embryonic Development of the Latter Species, in Different Temperature and Chlorinity Combinations.

Neth. Jour. Sea Research, 11, 305-315 (1977)

Both NEOMYSIS INTEGER and PRAUNUS FLEXOSUS have wide tolerance ranges for salinity. The tolerance experiments carried out with adults of both species showed a smaller chlorinity tolerance at higher temperatures than at lower ones, and this was more pronounced in PRAUNUS than in NEOMYSIS. In NEOMYSIS adapted to 12.8 ppt Cl, the highest tolerances were found at 5 C at 10 ppt Cl, at 15 C between 6 and 10 ppt Cl, and at 20 C between 4 and 10 ppt Cl. In PRAUNUS the chlorinity tolerances at 5 and 10 C reached higher chlorinity values than at 15 and 20 C. Oxygen consumption measured at 5, 10, 15, and 20 C and at chlorinities of 2 to 20 ppt showed that respiration rates of PRAUNUS at other than adaptation chlorinities often exceeded the respiration rate at the adaptation chlorinity. This was not seen in NEOMYSIS. It was concluded that NEOMYSIS is better adapted to live at low chlorinities than PRAUNUS. This conclusion was more pronounced at higher than at lower temperatures. (MU)

<421>

Voyer, R.A., C.E. Wentworth, Jr., E.P. Barry, and R.J. Hennekey, U.S.E.P.A., Environmental Research Laboratory, Narragansett, RI

Viability of Embryos of the Winter Flounder PSEUDOPLEURONECTES AMERICANUS Exposed to Combinations of Cadmium and Salinity at Selected Temperatures.

Marine Biol. (W. Ger), 44, 117-124 (1977)

Developing eggs of the winter flounder PSEUDOPLEURONECTES AMERICANUS (Walbaum) were exposed to 9 combinations of cadmium and salinity at 5 and 10 C. Overall mean times to 50% hatch ranged from 7.7 days at 10 C to 17.9 days at 5 C. Mean percentages of total hatches ranged from 50 to 100% for all treatment combinations. Response-surface analyses indicate percentages of viable hatches were generally lowest at 10 g/l S and highest in the 25 to 30 g/l S range. Regression analyses of viable hatch data show that at both temperatures cadmium significantly influenced viable hatch in all experiments. Viable hatch was also significantly influenced by the linear and quadratic effect of salinity in both tests at 5 C and in 2 of 3 tests at 10 C. The interaction between cadmium and salinity also significantly affected viable hatch at 10 C. (Auth)

<422>

Wakeman, J.M., The University of Texas at Austin

Environmental Effects on Metabolic Scope and Swimming Performance of Some Estuarine Fishes.

Ph.D. Thesis, The University of Texas at Austin, 161 pp. (1978)

The effect of temperature on standard metabolism, active metabolism, metabolic scope, and sustained swimming capability was investigated using several estuarine fishes (black drum, POGONIAS CROMIS; red drum, SCIAENOPS OCELLATA; spotted seatrout, CYNOSCION NEBULOSUS; sheepshead, ARCHOSARGUS PROBATOCEPHALUS). Acclimation temperatures ranged from 12 to 28 C, and Q10 values (1.2 to 1.5) indicated temperature compensation in these fishes. Scope for activity increased with temperature, exceeding standard metabolism by a factor of 3 to 5 at 28 C. Sustained swimming speed also increased with temperature. (MU)

<423>

Walz, N., Zoologisches Institut der Universitat Munchen, Abt. fur Okophysiologie und Limnologie, Munchen, Federal Republic of Germany

The Energy Balance of the Freshwater Mussel DREISSENA POLYMORPHA Pallas in Laboratory Experiments and in Lake Constance. I. Pattern of Activity, Feeding and Assimilation Efficiency.

Arch. Hydrobiol./Suppl. 55 (Ger.), 1, 83-105 (1978)

As a part of a series of investigations on the ecology of DREISSENA POLYMORPHA, a primary fouling organism of European

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freshwater systems, the effect of temperature on the filter-feeding rate was studied. The time filtered in each 24 hours was constant (16.8 h). The ingestion rate had an optimum at 12.5 C; its dependence on body size is presented as a power function. With a food concentration of 2 mg C/l, the assimilation efficiency for carbon was 40.1%. (ST)

<424>
Ward, G.M., Michigan State University, East Lansing, MI

The Influence of Detrital Food Quality and Temperature on the Life History and Growth of PARATENDIPES ALBIMANUS (Meigen) (Diptera: Chironomidae) in a Michigan Headwater Stream.
Ph.D. Thesis, Michigan State University, 108 pp. (1977)

The natural history, pattern of growth, and effects of temperature and detrital food quality on the growth of the stream detritivore PARATENDIPES ALBIMANUS were investigated in a natural stream and in the laboratory. Studies in the laboratory and in large scale experimental streams showed that variations in temperature, within the range 5 to 20 C, produced linear changes in larval growth rates; however, rates were constant when corrected for amount of heat accumulation (day-degrees). Day-degree accumulations proved to be a consistent estimate of developmental velocity and timing of emergence. An Augusta Creek, Michigan, population required 650 day-degree days after winter in order to begin emergence, while laboratory populations required approximately 700 day-degrees. Temperature was a general control of growth rates except when overridden by unavailability of food or other factors. (ST)

<425>
Webb, P.W., University of Michigan, School of Natural Resources, Ann Arbor, MI

Temperature Effects on Acceleration of Rainbow Trout, SALMO GAIRDNERI.
Jour. Fish. Res. Board Can., 35, 1417-1422 (1978)

Acceleration performance during and immediately following fast-starts was measured at 5, 10, 15, 20, and 25 C for rainbow trout (SALMO GAIRDNERI) of mean mass 23.5 g. Fast-start responses were initiated by an electric shock stimulus. Temperature had little effect on fast-start kinematics. Response latency and duration of propulsion strokes decreased with temperature. Latencies decreased from 23 ms at 5 C to 6 ms at 25 C. Times to complete the first two principal acceleration strokes in a fast-start decreased from 116 ms at 5 C to 65 ms at 25 C. Distance traveled in a given time increased with temperature. For an elapsed time of 100 ms, the distance traveled was 3.5 cm at 5 C increasing to 11.3 cm at 25 C. Velocity increased with time at each temperature to reach maximum values by the end of the third propulsive stroke and thereafter declining. Maximum velocity increased with temperature from 0.99 m/s at 5 C to 1.71 m/s at 15 C. Maximum velocity was independent of temperature from 15 to 25 C. Similar trends were found for maximum acceleration rate which increased from 16 m/s2 at 5 C to 41 m/s2 over the 15-25 C range. Temperature effects on acceleration performance would alter the ability of fish to traverse short areas of high velocity flow, the effectiveness of predators, and vulnerability of prey fish. (Auth)

<426>
Weiss, C.M., T.P. Anderson, P.H. Campbell, D.R. Lenat, J.H. Moore, S.I. Pfaender, and T.G. Donnelly, University of North Carolina at Chapel Hill, Department of Environmental Sciences and Engineering, School of Public Health, Chapel Hill, NC

An Assessment of the Environmental Stabilization of Belews Lake - Year IV and Comparisons with Lake Hyco, North Carolina, July 1973 - June 1974.
ESE Publication No. 416, University of North Carolina, 515 pp. (1975)

Parallel studies on Belews Lake (preoperational) and Lake Hyco, NC, used as a cooling impoundment since 1966 were continued. These included studies on limnology, phytoplankton, zooplankton, benthos, chlorine residuals, and aquatic vegetation. A final chapter addressed the significance of spatial and temporal differences in chemical and biological parameters between sampling sites as tested by analysis of variance. Decreases in gross primary productivity and phytoplankton density and taxon numbers were localized in the discharge pool in Lake Hyco. Zooplankton densities were difficult to correlate with the presence or absence of heat addition. Analysis of profundal and sublittoral data from Lake Hyco indicated that two Chironomidae were affected by power plant operation. CHIRONOMUS was absent from the discharge pool at all times. PROCLADIUS was found in the discharge area during the present year of sampling, but showed an abnormal growth pattern. The littoral HEXAGENIA (mayfly) and ANODONTA (clam) were adversely affected by thermal effluent (maximum temperature in the discharge pool 40 C). Chironomid biomass was 85% lower in comparison to control stations. CHAOBORUS standing crop was reduced near intake areas. Littoral organisms tolerant of elevated temperatures included PHYSA, PROSTOMA, ARGIA and various Naididae. (ST)

<427>
Weiss, C.M., T.P. Anderson, P.H. Campbell, D.R. Lenat, J.H. Moore, and S.L. Pfaender, University of North Carolina at Chapel Hill, Department of Environmental Sciences and Engineering, School of Public Health, Chapel Hill, NC

Environmental Comparison: Belews Lake - Year III and Lake Hyco North Carolina, July 1972 - June 1973.
ESE Publication No. 370, University of North Carolina, 537 pp. (1974)

Parallel investigations were conducted on Belews Lake, NC, which is to be used as a cooling impoundment for the Belews Creek steam station, and Lake Hyco, a cooling water pond of comparable surface acreage. Lake Hyco has been used as a source of cooling water for the Roxboro steam station since May, 1966. The studies included monthly surface samples for water characterization plus quarterly profiled samples at selected deep stations. Physical and chemical characteristics of the two lakes were linked to biological samples to establish spatial and temporal sequences of the phytoplankton and zooplankton. Benthic macroinvertebrates of Belews Lake were seasonally sampled at locations chosen to reflect effects of the power load when Belews Creek station becomes operational in early summer of 1974. Benthic samples were also collected from comparable locations in Lake Hyco where the biota has been subjected to heat load for several years. Changes in peripheral terrestrial vegetation were also

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noted. Two energy flow models have been derived from the comparative study of the benthic systems of the two lakes. (ST)

<428>
Wellings, F.M., P.T. Amuso, S.L. Chang, and A.L. Lewis, Department of Health and Rehabilitative Services, Tampa, FL

Isolation and Identification of Pathogenic NAEGLERIA from Florida Lakes.
Appl. Environ. Microbiol., 34, 661-667 (1977)

Five cases of primary amoebic meningoencephalitis associated with swimming in freshwater lakes have been recorded in Florida over the past 14 years. The present study demonstrated that pathogenic NAEGLERIA, the causative agent, is relatively widespread. Twelve of 26 lakes sampled only once yielded the amoeba. Populations in three of five lakes sampled routinely reached levels of one amoeba per 25 ml of water tested during the hot summer months. Overwintering in freshwater lake bottom sediments was demonstrated, showing that thermal-discharge pollution of waters plays a miniscule, if any, role in the maintenance of pathogenic NAEGLERIA in nature in this semitropical area. (Auth)

<429>
Wellings, F.M., A.L. Lewis, P.T. Amuso, and S.L. Chang, Department of Health and Rehabilitative Services, Tampa, Florida; U.S. EPA, Epidemiology Branch, Health Effects Research Laboratory, Cincinnati, OH

NAEGLERIA and Water Sports.
Lancet, No. 8004, 199-200 (1977)

Photogenic NAEGLERIA were isolated from thermally and non-thermally polluted lakes in Florida. Fifty-eight (15 of 26) of the lakes tested yielded the agent, either from bottom mud or water samples. Temperatures of the control lakes yielding isolates ranged from 16 to 34.5 C. No isolates were obtained from lake waters, including the thermally polluted lake, when the water temperature dropped below 26.5 C. However, isolates were obtained from bottom mud samples even when temperatures dropped to 16 to 18 C in December. (ST)

<430>
Wells, F.E., Dalhousie University, Department of Oceanography, Halifax, Nova Scotia, Canada

The Relationship Between Environmental Variables and the Density of the Mud Snail HYDROBIA TOTTENI in a Nova Scotia Salt Marsh.
Jour. Molluscan Studies, 44, 120-129 (1978)

The relationship between environmental variables and the density of HYDROBIA TOTTENI was examined in a restricted area of Lawrencetown Marsh, Nova Scotia (Canada). Densities averaged 50/m2 in SPARTINA ALTERNIFLORA, 9800/m2 in ZOSTERA MARINA, and 19,000/m2 in sand. Of 8 environmental factors considered, depth and sediment grain size were the most important in explaining variations in snail density. Since these factors together explained only 42.0% of the total variation no single physical factor controls the density of HYDROBIA in a restricted area, though salinity does control densities over a wide area. Wide tolerances of H. TOTTENI to salinity and temperature were demonstrated. Snails were active in salinities of 10 to 40 ppt at temperatures of 4, 10, and 20 C. HYDROBIA in water survived temperatures of 4 to 30 C. Snails kept dry survived well at 4 C, but survivorship decreased above and below that

<427>
temperature. Snails were able to select the sediment grain size found in the marsh when offered a choice of four grain sizes. Relationships between the tolerances of H. TOTTENI and the environmental factors are discussed. (Auth) (MU)

<431>
Whitaker, J.O., Jr., R.A. Schlueter, and G.A. Tieben, Indiana State University, Terre Haute, IN

Effects of Heated Water on Fish and Invertebrates of White River at Petersburg, Indiana.
Water Resources Research Center, Report of Investigations No. 8, Indiana University, Bloomington, IN (1977)

This is the fourth in a series of reports by Indiana State University personnel on the effects of the heated effluent from the Indianapolis Power & Light Company Generating Plant on the White River. Data on invertebrates and fish collected during the period 1972-1976 are reported and compared with previous study periods. Scope of the study during this report period was enlarged to cover impingement; distribution and growth of catfish; possible synergistic effects from more than one plant; preferred temperature, diseases, and movement of fish; extent of the heated effluent mixing zone; and shifts in abundance of some fish species, particularly emerald shiner, white sucker, sauger, and redhorse suckers. The major species of fish impinged were gizzard shad (90.8%), channel catfish (4.1%), and buffalo (1.4%). Although comparison of the fish community of 1971-72 showed some differences in species composition, especially of some of the less common species, the number of species was similar. Redhorse suckers had disappeared, probably because their habitat had been destroyed. There was movement of fish into the unheated water in summer and into the heated water in winter. This trend was not well developed for bottom fish such as catfish. The chironomid GLYPTOTENDIPES made up 23% of the upstream invertebrates and 95% of the heated water individuals. The combined effects of two plants did not create effects any different from those of IPALCO alone. The authors conclude that the plant is not appreciably harming the river. (ST)

<432>
Whitfield, P.J., R.M. Anderson, and D.A.P. Bundy, King's College, Zoology Department, Strand, England

Experimental Investigations on the Behavior of the Cercariae of an Ectoparasitic Digenean TRANSVERSOTREMA PATIALENSE: General Activity Patterns.
Parasitology, 75, 9-30 (1977)

The activity patterns of the cercariae of TRANSVERSOTREME PATIALENSE were examined by monitoring the behavior of individual larvae. Records of three different behavioral modes, namely active, tail-first swimming, passive dropping, and resting periods were made separately. The age- and temperature-dependence of the activity patterns during the spontaneously active life of the cercariae were examined and estimates made of the absolute speeds of swimming and dropping. Through the temperature range 25 to 32 C, the spontaneously active life of cercariae declined from about 18 h to about 6 h. Within this interval, after an initial period of high activity rates, a gradual decline in activity followed. The decline was a result of a decreasing frequency of swimming events rather than any change in the durations of such events. The neural

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control and energetic significance of the cercarial activity patterns are discussed. (Auth)

<433>
Whittick, A., Memorial University, Department of Biology, St. John's, Newfoundland, Canada

The Life History and Phenology of CALLITHAMNION CORYMBOSUM (Rhodophyta: Ceramiaceae) in Newfoundland.
Can. Jour. Bot., 56, 2497-2495 (1978)

CALLITHAMNION CORYMBOSUM reaches its known northern limits in the western Atlantic in Newfoundland where it occurs only as tetraspore-bearing plants which reproduce by vegetative fragmentation. Culture of the vegetative fragments from a single plant produced vigorous growth and production of tetrasporangia at 10 and 15 C and little growth and no tetrasporangia at lower temperatures. Vegetative growth occurred at 10 C:16 h light, 8 h dark: 2300 lx, but no tetrasporangia were produced; however, plants transferred to 500 lx after 56 days at 2300 lx produced tetrasporangia in 4 days. The higher light intensities proved lethal at 2 C, but at 150 lx plants remained viable and when transferred to 10 C: 16 h light, 8 h dark: 500 lx after 96 days at 2 C produced tetrasporangia in 28 days. (MU)

<434>
Widdows, J., Institute for Marine Research, Prospect Place, Plymouth, England

Physiological Indices of Stress in MYTILUS EDULIS.
Jour. Mar. Biol. Assn. U.K., 58, 125-142 (1978)

Multiple regression equations and response surfaces were used to describe the combined effects of body size, food concentration, acclimation temperature and season on physiological integrations such as the scope for growth, growth efficiency and O:N ratio. Maintenance and optimum ration levels are estimated for MYTILUS EDULIS adapted to different factor combinations. Response surfaces illustrate the validity and sensitivity of the physiological integrations in qualifying the 'physiological condition' and the degree of stress experienced, under conditions ranging from near-optimal, through sub-lethal to lethal. (Auth)

<435>
Widdows, J., Institute for Marine Environmental Research, Prospect Place, Plymouth, England

Combined Effects of Body Size, Food Concentration and Season on the Physiology of MYTILUS EDULIS.
Jour. Mar. Biol. Assn. U.K., 58, 109-124 (1978)

Multivariate experiments were used to study the effects of body size, food concentration, and season on the oxygen consumption, ammonia excretion, food assimilation efficiency and filtration rate of MYTILUS EDULIS adults. Food concentrations and season affected both the intercept and the slope of the allometric equation describing oxygen uptake as a function of body size. Multiple regression and response surface techniques were used to describe and illustrate the complex relationship between metabolic rate, ration, season and the body size of M. EDULIS. Filtration rate had a relatively low weight exponent (b = 0.38) and the intercept for the allometric equation was not significantly affected by food concentration, season or acclimation temperatures between 5 and 20 C. Food assimilation efficiency declined exponentially with increasing food concentration and was dependent on body size at high food levels. The rate of ammonia excretion showed a similar seasonal cycle to that of oxygen consumption. They were both minimal in the autumn/winter and reach a maximum in the spring/summer. (Auth)

<436>
Williams, G.E., Texas A&M University, College Station, TX

Population Characteristics of Estuarine Decapod Crustaceans in Intake and Discharge Areas of the Cedar Bayou Electric Power Station before and during Construction and Operation.
Ph.D. Thesis, Texas A&M University, 479 pp. (1977)

Crustacean abundance, distribution, and taxonomic composition in intake and discharge areas before and during operation of the Cedar Bayou, Texas, power plant were determined. Plant shut-downs because of mechanical problems and implementation of a 2600 acre cooling pond resulted in little elevation of ambient temperature during warmest periods. Flow reversal of water in Cedar Bayou (intake) improved water quality and resulted in increased diversity and crustacean abundance. Discharge of higher salinity cooling water into lower salinity receiving waters in Trinity Bay disrupted normal upbay-downbay salinity gradients and altered salinity-related distributional patterns of dominant species. Operation of one 750 mw unit had few detrimental effects. Addition of a second unit resulted in increased discharge volume. Blue crabs and grass shrimp were attracted to affected shoreline stations, but brown shrimp and white shrimp displayed some avoidance of the plume. Salinity conditions and resultant species abundance patterns in the discharge area (Trinity Bay) were greatly influenced by yearly fluctuations in Trinity River flow. (ST)

<437>
Williams, J.B., North Carolina, State University at Raleigh, NC

Productivity, Population Dynamics, and Physiological Ecology of the Dwarf Surf Clam, MULINIA LATERALIS, near a Power Plant Intake Canal, Southport, North Carolina.
Ph.D. Thesis, North Carolina State University, 175 pp. (1978)

Populations of the dwarf surf clam, MULINIA LATERALIS, living in different habitats in the lower Cape Fear River estuary, NC, were sampled biweekly over a one year period. Observations were made to determine seasonal changes of clam density, biomass, and length frequency and to relate these changes to different physical and biological factors. Predators were also identified. Clam density exhibited distinctly seasonal cycles of abundance with numbers highest in late winter to early spring and low levels in summer. The major predator was CALLINECTES SAPIDUS. In the laboratory observations were made to compare the relative effects of temperature (15, 20, 25, 30, and 32 C) and salinity (10, 15, 20, 25, and 30 ppt) on respiration rate. Temperature affected M. LATERALIS respiration rate to a greater degree than salinity, but the interaction effects between temperature and salinity were also significant. At most temperatures respiration rates were similar over a wide salinity range. (ST)

<438>
Williams, S.F., and R.S. Caldwell, Oregon State
University, Marine Science Center,
Department of Fisheries and Wildlife,
Newport, OR

Growth, Food Conversion and Survival of 0-Group English Sole (PAROPHRYS VETULUS Girard) at Five Temperatures and Five Rations.
Aquaculture, 15, 129-139 (1978)

Laboratory experiments were conducted to determine the effects of temperature and food ration on growth, conversion efficiency and survival of 0-group English sole (PAROPHRYS VETULUS Girard). Young sole, fed a diet of Oregon Moist Pellets, were exposed to constant temperature-ration combinations between 9.5 and 21 C and between 0 and 16% rations (dry weight basis) for a 12-week experimental period. The juvenile sole, initially 4-6 g, grew at a rate of up to 0.95% per day at the most favorable temperature-ration combination, 9.5 C and 16% ration. Highest food conversion efficiency, 10.5%, was observed at the temperature-ration combination of 9.5 C and 8% ration. At 21 C, young sole lost weight at the ration levels fed. Based on growth rate, survival and food conversion efficiencies observed during the experiments and the temperatures to which the young sole are exposed in nature, the temperature at which greatest growth and maximum food conversion efficiency occurs is probably near or below 9.5 C. (Auth) (ST)

<439>
Wilson, J.C., The University, Zoology Department,
Glasgow, Scotland

Upper Temperature Tolerances of TELLINA TENUIS and T. FABULA.
Marine Biol. (W. Ger.), 45, 123-128 (1978)

The upper lethal temperature tolerances of TELLINA TENUIS and T. FABULA were studied under a variety of temperature regimes in which both long-term and short-term mortality were noted. In the short-term (24 h) experiments the lethal dose for 50% mortality was 31.25 C for T. TENUIS and 26.5 C for T. FABULA. In the long-term experiments T. TENUIS was more tolerant than T. FABULA of both high and low temperatures. Acclimation to higher temperatures enhanced ability to withstand higher experimental temperatures. There was no significant variation in the mortality rate of T. TENUIS with season or age at collection. Differences in tolerances between the two species could not be correlated with geographic distribution, but did reflect their respective littoral and sublittoral distributions. (ST)

<440>
Windell, J.T., J.W. Foltz, and J.A. Sarokon,
University of Colorado, Department of
Environmental, Population and Organismic
Biology, Boulder, CO

Effect of Fish Size, Temperature, and Amount Fed on Nutrient Digestibility of a Pelleted Diet by Rainbow Trout, SALMO GAIRDNERI.
Trans. Amer. Fish. Soc., 107, 613-616 (1978)

Comparisons were made of digestibility coefficients for nutrients in a dry pellet diet fed to three sizes (18, 207, 586 g) of rainbow trout, SALMO GAIRDNERI, at three water temperatures (7, 11, 15 C), and for three meal sizes (0.4, 0.8, 1.6% of fish weight) fed to one fish size (194 g) at one water temperature (11 C). No significant differences were apparent between body sizes at temperatures of 11 and 15 C. However, digestibility coefficients for all nutrients were significantly lower for 18-g trout acclimated to 7 C than 207- or 586-g trout at 7 C or 18-g fish acclimated to 11 and 15 C. The grand average coefficients for protein, lipid, and energy, excluding small fish at 7 C, were 93%, 89%, and 74% whereas values for the small fish were 20%, 9%, and 28% lower, respectively. No difference was apparent in the digestibility of protein or lipid at rations of 0.4, 0.8, and 1.6% of the fish body weight. Future digestibility studies with rainbow trout may expect no effect of water temperature and body size within the ranges in this study except for small fish (18 g) at the lowest temperature (7 C). Meal sizes should approximate those fed under normal culture conditions. (Auth)

<441>
Wisniewski, R.J., Polish Academy of Sciences,
Department of Hydrobiology, Institute of
Ecology, Lomianki, Poland

Effect of Heated Waters on Biocenosis of the Moderately Polluted Narew River. Oligochaeta.
Pol. Arch. Hydrobiol., 23, 527-538 (1976)

The effects of a power station effluent on the benthic oligochaete communities was studied in the slightly polluted lowland Narew River (Poland). The investigations covered a 113-km-long sector of the river starting about 1 km upstream from the Ostroleka power plant and continuing down to the Zegrzynski Dam Reservoir. The power station effluent caused a slight heating of the river waters (about 2 C). The increased temperature caused sudden fluctuations in the density of Oligochaeta that were not observed in the unheated zones of the river. These violent fluctuations were presumably caused by changes in the life-cycle of the Oligochaetes. Intensive sexual reproduction was accelerated by a few weeks, the ratio of mature individuals in the population was increased, and there was a change in the rhythm of inflow of young individuals. (MU)

<442>
Wong, S.L., B.C. Kirby, and R.F. Kosciuw, Ontario
Ministry of the Environment, Water Resources
Branch, Limnology and Toxicity Section,
Rexdale, Ontario, Canada

Water Temperature Fluctuations and Seasonal Periodicity of CLADOPHORA and POTAMOGETON in Shallow Rivers.
Jour. Fish. Res. Bd. Can., 35, 866-870 (1978)

The influence of water temperature on nuisance plant species in seven river systems in southwestern Ontario was investigated. Nutrients were not limiting. The study period covered the low flow season from May to September, 1973-76. A community dominated by CLADOPHORA GLOMERATA in late spring is usually replaced by a POTAMOGETON PECTINATUS dominated community. The tolerance limits of C. GLOMERATA and P. PECTINATUS at fixed values of the daily mean or daily maximum temperature change with the daily temperature range. Two methods of predicting daily range were derived. An intermediate seasonal temperature (18 to 22 C, less than 4 C daily temperature fluctuation) supported a mixed plant community. Maintenance of appropriate temperature conditions could provide a management technique for controlling nuisance plant growths or for establishing a diverse community in shallow rivers. (Auth)

<443>
Wood, D.H., Savannah River Ecology Laboratory,
Aiken, SC

<443>
<443> CONT.
Temperature Adaption in the Freshwater Snail, HELISOMA TRIVOLVIS (Say), in an Artificially Heated Reservoir in the Southeastern United States.
Jour. Thermal Biol., 3, 187-194 (1978)

Snails from a heated zone of Par Pond of the Savannah River Plant were compared with conspecifics from an unheated area of the same reservoir. The heated area averaged 5 C warmer and thermally more variable than the control area. This situation has existed for about twenty years. Variation in metabolic response to temperature was observed according to season and heated vs unheated area. A laboratory rearing experiment indicated that part of the observed variation was environmentally induced. Life cycle and growth rates were similar in the two collection areas. Three generations were produced annually in both areas and spawning was synchronous except that the summer spawning period was shorter in the heated area. Live weights expressed relative to shell size were also similar, and decreased in both areas during summer. It appears from these results that metabolic compensation for temperature can serve as an indicator of general thermal adaptability, but only if the degree of environmental plasticity is known for the species. (Auth)

<444>
Wroblewski, A. (Ed.), Polish Academy of Sciences, Institute of Systematic and Experimental Zoology, Krakow, Poland

Bottom Fauna of the Heated Konin Lakes.
Monografie Fauny Polski, Volume 7. Panstwowe Wydawnictwo Naukowe, Krakow, Poland (1977)

The five Konin Lakes (Poland) have received heated effluents for various periods of time and are presently heated to different degrees. The first power station with its once-through cooling system began operation in 1958. Studies on the fauna of these lakes were initiated in 1970. Following a description of the lakes and their origin, respective chapters of the monograph describe the effects of heated effluents on Turbellaria and Nemertini, Oligochaeta, Hirudinea, Mollusca, Ostracoda, Odonata, Micronectinae (Heteroptera, Corixidae), Heteroptera excluding Micronectinae, Coleoptera, and Hydracarina. (ST)

<445>
Yaguchi, E.M., Argonne National Laboratory, Ecological Sciences Section, Argonne, IL

Nutrients and Productivity as Indicators of Thermal Efflaent - Upwelling Interactions in Lake Michigan.
Jour. Great Lakes Res., 3, 57-64 (1977)

During the summer of 1975, a field study was undertaken to examine separate and combined effects of upwelling and a thermal discharge on nutrients, productivity quotients, and phytoplankton populations in an inshore region of southwestern Lake Michigan. Reactive silicate concentrations were more than doubled during the upwelling (compared to those during stable hydrological conditions); chlorophyll-a concentrations, phytoplankton diversity, and cell numbers per milliliter were also significantly greater. Productivity quotients were lower by nearly one-half during upwelling. The Zion Nuclear Plant discharges water warmed an average of 10 C to the lake via a submerged high-velocity discharge. Few significant differences in chemical and biological parameters were attributable to the resulting warm-water plume. Phytoplankton specific growth rates in the plume were increased over those at control stations only during upwelling. Nutrient limitation is implicated as one of several factors in the response of phytoplankton to locally increased temperature. (Auth)

<446>
Yefimova, T.A., and Yu.I. Nikanorov, Upper Volga Department of the State Research Institute for Lake and River Fisheries, Konakovo, USSR

Prospects for the Introduction of Phytophagous Fishes into Ivan'kovskoye Reservoir.
Jour. Ichthyol., 17, 634-644 (1977)

The total area of weed-beds and the production of macrophytes in Ivan'kovskoye reservoir has increased considerably in recent years and together with other factors this impairs the quality of the water and the reproductive success of fish. The increase in the water temperature under the influence of waste waters from the regional power station, the increased growth of vegetation and the more intensive development of phytoplankton create favorable conditions for the introduction of phytophagous fishes, enabling additional commercial production to be obtained and the quality of the water to be improved. The rearing of young phytophagous fishes must be carried out in special fish hatcheries, using the warm water supply from the regional power station. (Auth)

<447>
Yeh, C.F., Texas A&M University, Department of Wildlife and Fisheries Service, College Station, TX

Production of White Crappie in Lake Nasworthy, Texas.
Southwestern Naturalist, 23, 111-116 (1978)

Estimates of production of white crappie, POMOXIS ANNULARIS, were made for Lake Nasworthy, Texas, on the basis of mark and recapture studies undertaken in 1969. Estimated biomass varied seasonally from 16.9 to 59.2 kg/ha. Estimated production of 6.1 kg/ha is in the lower end of the reported range for fish that predominate in temperate zones. (Auth)

<448>
Young, A.M., and T.L. Hazlett, III, University of South Carolina, Baruch Institute for Marine Biology and Coastal Research, Columbia, SC

The Effect of Salinity and Temperature on the Larval Development of CLIBANARIUS VITTATUS (Bose) (Crustacea: Decapoda: Diogenidae).
Jour. Exp. Mar. Biol. Ecol. (Neth.), 34, 131-141 (1978)

CLIBANARIUS VITTATUS (Bose) larvae werre reared in twenty combinations of four salinities (15, 20, 25, and 30 ppt and five temperatures (15, 20, 25, 30, and 35 C). No development was observed in any salinity at 15 C, but partial development occurred in all other test conditions. Metamorphosis to juvenile crabs was noted only at salinities of 25 and 30 ppt in combination with temperatures of 25 and 30 C. In general, development times were decreased at higher temperatures; no trend was evident for salinity. Mortality of zoeae was usually highest at the time of the first molt and greatest overall mortality occurred during the megalopa stage prior to metamorphosis. Previous experiments have shown that C. VITTATUS adults can tolerate temperatures down to 5 C. It is suggested that the geographic distribution of C. VITTATUS (Virginia, southwards) is limited not by adult tolerances but by the inability of the

<448> CONT.
species to establish a breeding population. Larvae require two months at 25 C or above to metamorphose, and this condition is not met in areas north of Virginia. (Auth)

<449>
Young, J.W., and C.W. Apts, Battelle Pacific Northwest Laboratories, Marine Research Laboratory, Sequim, WA

Thermal Shock Tolerances of Six Fishes and one Invertebrate from the Pacific Northwest.
BNWL-2209, 8 pp.; National Technical Information Service, Springfield, VA (1977)

The purpose of the study was to ascertain the temperature at which selected estuarine fish from the Pacific Northwest and one of their potential food organisms would be incapacitated and killed after entering the thermal plume of an industrial cooling system. Equilibrium loss and thermal death as endpoints for different rates of temperature increase of six fishes and one invertebrate are presented. The species tested were shiner perch, CYMATOGASTER AGGREGATA; coho salmon, CNCORHYNCHUS KISUTCH; Pacific sandlance, AMMODYTES HEXAPTERUS; threespine stickleback, GASTEROSTEUS ACULEATUS; silverspotted sculpin, BLEPSIAS CIRRHOSUS; Pacific staghorn sculpin, LEPTOCOTTUS ARMATUS; and the mysid, MYSIS OCULATA. Equilibrium loss and death temperatures, adjusted for differences in length and weight of the organisms, and at two rates of heating, 2.0 and 6.0 C increase/min, are presented in tabular form. Test organisms were held for two weeks in flow-through aquaria at ambient water temperature (10 to 11 C, 30 ppt salinity) before heating. A second group of sticklebacks was acclimated at 20 C before testing. Equilibrium loss temperatures were consistently a few degrees lower than the corresponding death temperatures. No equilibrium loss was exhibited by mysids. (ST)

<450>
Young, L.G.L., Texas A&M University, College Station, TX

Some Aspects of Salinity and Temperature Stress on NEANTHES ARENACEODENTATA Moore.
Ph.D. Thesis, Texas A&M University, 163 pp. (1977)

The effects of thermal and salinity stress on several physiological functions of NEANTHES ARENACEODENTATA were studied. Ingestion increased with temperature at 32 ppt, but at 22 ppt, an optimal rate was seen at 20 C. Egestion at 32 ppt showed an optimal rate at 20 C, but at 22 ppt, egestion increased with increasing temperature. Weight gains occurred above 20 C and 22 ppt. Optimal growth rates were observed at 20 C. (ST)

<451>
Zaar, E.I., V.A. Topolovsky, and G.M. Tribis, All-Union Research Institute of Agricultural Microbiology, All-Union Research Institute of Plant Protection, Leningrad, USSR

Effect of Temperature Change on the Reproduction of PARAMECIUM CAUDATUM.
Zhurnal Olishchii Biol. (USSR), 38, 609-620 (1977)

Experimental data are presented on the effect of circadian temperature changes with amplitudes of 6, 12, 20, and 28 C on the reproduction of PARAMECIUM CAUDATUM. With temperature changes of 28 to 16 C and 22 to 10 C, the division rates of infusoriae are 1.4 to 3.0 times higher than those at average constant temperatures (22, 14, 13,

10, 7, 6 C). No division stimulation was observed if the fluctuation involved sublethal temperatures (from 28 to 0.5 C). Thus, at circadian temperature changes, the sum of effective temperatures being equal, the rate of division of PARAMECIUM CAUDATUM depends on the amplitude of the temperature change. (Auth)

<452>
Zachery, A., Virginia Institute of Marine Science, Gloucester Point, VA

An Ecological Study of Bacteriophages of VIBRIO NATRIEGENS.
Can. Jour. Microbiol., 24, 321-324 (1978)

Effects of temperature and anaerobic conditions on the replication of two phages, nt-1 and nt-6, of the estuarine bacterium VIBRIO NATRIEGENS were studied. Reduction in temperature resulted in longer latent periods and reduced burst sizes for both phages. Replication under anaerobic conditions resulted in longer latent periods; however, phage nt-6 had a reduced burst size, whereas phage nt-1 had an increased burst size, resulting in a rate of phage production nearly equal to that observed under aerobic conditions. Therefore the distribution of the phages in marsh areas could be influenced by temperature and anaerobiosis. (Auth)

<453>
Zeitoun, I.H., Consumers Power Company, Department of Environmental Services, Jackson, MI

Assessment of Intermittently Chlorinated Heated Effluents on Survival of Adult Rainbow Trout (SALMO GAIRDNERI) at Power Generating Facilities.
Environ. Sci. & Technol., 12, 1173-1179 (1978)

Monthly 96-h bioassays were carried out from November 1975 to June 1976 at the J.H. Campbell Plant of the Consumers Power Co., Michigan, to determine the effects of intermittent chlorination on the survival of caged rainbow trout (SALMO GAIRDNERI). The results indicated that eight covariates, which included total and free chlorine-exposure time integrations, dissolved oxygen supersaturation and temperature, contributed significantly to the mortalities exhibited among caged fish. Squared multiple correlation coefficients were used to determine the relative effects of these significant covariates on fish mortality since the individual function of these variables appeared to be additive. A maximum value of 0.3 mg/L TRCl per 54 min of exposure time was extrapolated as a safe concentration that would result in the same mortality rate as in controls which were not exposed to chlorine. Blood analysis indicated that chlorine was not the primary cause of the observed stress. (Auth)

<454>
Zimmerman, M.C., Miami University, Oxford, OH

Aspects of the Life History, Feeding Behavior, and Nutritional Dynamics of the Burrowing Mayfly, HEXAGENIA LIMBATA in an Ohio Pond.
Ph.D. Thesis, Miami University, 185 pp. (1977)

Population densities, fecundity, nutritional dynamics, and feeding behavior of the burrowing mayfly, HEXAGENIA LIMBATA, were studied during 1973-1977 in an Ohio pond. Multiple stepwise regression analysis and maximum R2-improvement analyses indicated that sediment type was the most probable single variable affecting the population distribution, with depth, date, dissolved

<454>
<454> CONT.

oxygen, and temperature assuming lesser importance. Rates of movement of two natural sediments of differing color through the digestive tract were monitored to quantify feeding intensity when ambient water temperatures approached 5, 10, 15, 20, and 25 C. At each temperature gut-loading times (GLT) and gut-clearing times (GCT) increased as nymph length increased. Mean GLT and GCT values decreased as temperature increased from 5 to 20 C, but were longer at 25 C than at 20 C. Relationships between gut-loading times and gut-clearing times (in h) and length (in mm) of naiads and temperature were best described by multiple regression equations. A stepwise selection procedure indicated that temperature was the best single variable predicting these relationships. Declines in water temperature depressed ingestion and egestion rates and consumption indices. At most temperatures nymphs ingested over 100% of their dry body weights per day. (ST)

<455>
Zimmerman, M.C., and T.E. Wissing, Miami
University, Department of Zoology, Oxford, OH

Effects of Temperature on Gut-Loading and
Gut-Clearing Times of the Burrowing Mayfly,
HEXAGENIA LIMBATA.
Freshwater Biology, 8, 269-277 (1978)

The effect of temperature on gut-loading times, gut-clearing times, and the calculated ingestion rates, egestion rates, and consumption indices of the deposit-feeding burrowing mayfly, HEXAGENIA LIMBATA, were investigated in laboratory experiments. Rates of movement of two natural sediments of differing colour through the digestive tract were monitored to quantify feeding intensity when ambient water temperatures approached 5, 10, 15, 20, and 25 C. At each temperture, gut-loading times (GLT) and gut-clearing times (GCT) increased as nymph length increased. Mean GLT and GCT values decreased as temperature increased from 5 to 20 C but were longer at 25 C than at 20 C. Relationships between GLT, GCT, and length of nymphs and temperature increased from 5 to 20 C but were longer at 25 C variation in gut-clearing times was observed. Low water temperatures resulted in lower ingestion and egestion rates and consumption indices. At most temperatures nymphs ingested over 100% of their dry body weights per day. (Auth)

<456>
Zimmerman, M.S., and R.J. Livingston, Florida
State University, Department of Biological
Science, Tallahassee, FL

Seasonality and Physico-Chemical Ranges of
Benthic Macrophytes from a North Florida
Estuary (Apalachee Bay).
Contrib. Marine Sci., 20, 33-45 (1976)

Samples were taken for 15 months in Apalachee Bay, north Florida to determine the seasonality of the various species of benthic macrophytes. A total of 39 species was collected. Quantitatively the flora was dominated by the seagrass, THALASSIA TESTUDINUM, and the green alga, HALIMEDA INCRASSATA. The phylum Rhodophyta had the largest representation with 17 species. The flora was warm temperate with many eurythermal tropical species. One species, POLYSIPHONIA HARVEYI, was shown to have a disjunct distribution and a temperate origin. Environmental limits (temperature, salinity) for each species were presented. Most species appeared to be eurythermal, which was considered an adaptation of tropical species for existence in a warm temperate region. Both euryhaline and stenohaline species coexist in Apalachee Bay. Species distribution in response to factors such as turbidity, color, and depth was discussed. (Auth)

<457>
Zwingelstein, G., N.A. Malak, and G. Brichow,
C.N.R.S., Laboratoire de Physiologie
generale et comparee de l'Universite Claude
Bernard Lyou 1., Villeurbanne, France

Effect of Environmental Temperature on
Biosynthesis of Liver Phosphatidyl-Choline
in the Trout (SALMO GAIRDNERI).
Jour. Thermal Biology, 3, 229-233 (1978)

The changes in fatty acid composition of trout liver phosphatidyl-choline, when the environmental temperature was increased, resulted in modifications in the amounts of the different molecular species. In vivo incorporation of P-32 occurred more rapidly in the molecular species with a high degree of unsaturation. Temperature acclimation did not modify the relative proportions of label shown in the five subfractions. In vitro incorporation of C 14-methyl-choline also occurred more rapidly in the most unsaturated molecular species. However, when the incubation period was raised, the proportion of label decreased in the unsaturated fractions. (Auth)

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